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A Suggested Unit Course

MARINE SHEET METAL SHOP PRACTICE

PART I — VENTILATION

(For Pre-employment Instruction)

Bulletin 346

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF PUBLIC INSTRUCTION
HARRISBURG
1942

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#346
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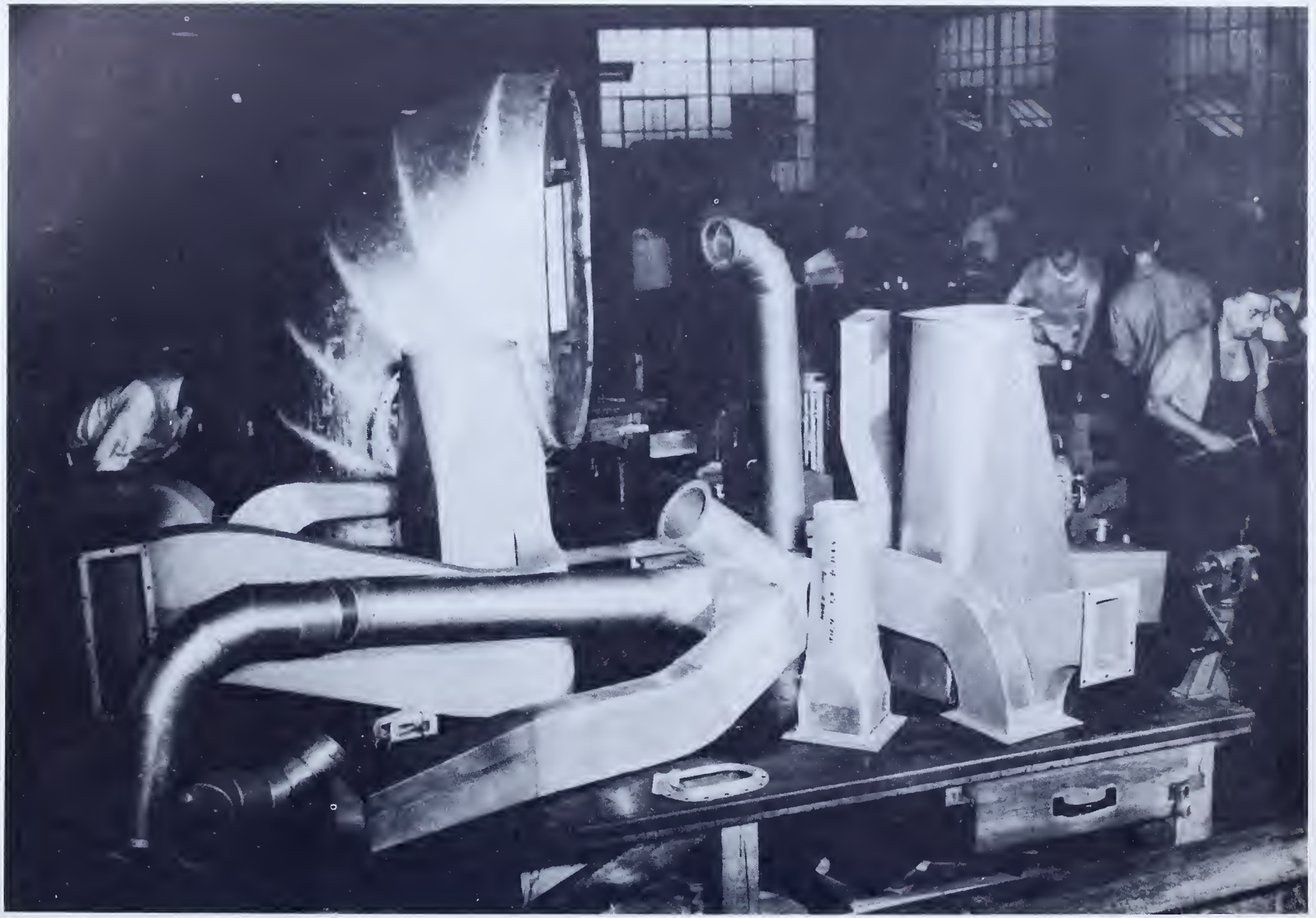
Vocational Education
for
National Defense



FABRICATED SHAPES — SHEET METAL SHOP
Cramp Shipbuilding Company

A Suggested Unit Course

MARINE SHEET METAL SHOP PRACTICE

PART I — VENTILATION

(For Pre-employment Instruction)

Bulletin 346

Prepared by

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF PUBLIC INSTRUCTION
DIVISION OF INDUSTRIAL EDUCATION

In Cooperation With

SCHOOL DISTRICT OF PHILADELPHIA
SHIPBUILDING YARDS IN THE PHILADELPHIA AREA
and
UNITED STATES OFFICE OF EDUCATION
FEDERAL SECURITY AGENCY

Q 38.19
I.3.1
#34

Commonwealth of Pennsylvania
DEPARTMENT OF PUBLIC INSTRUCTION
Harrisburg
July, 1942

This Material Was Prepared
In Cooperation With the
United States Office of Education
The Federal Security Agency
Washington, D. C.

Foreword

This bulletin is one of a series of units of instruction prepared expressly for use in training marine sheet metal workers. In that this unit is intended for pre-employment instruction, the development of skill in the use of fundamental hand and machine tools and processes is emphasized.

This unit of instruction presents job experiences which have been carefully selected to embrace work which is typical of the shop fabrication of marine sheet metal ventilation shapes. Jobs are presented in a sequence which permits the trainee to progress to more difficult work without encountering an objectionable number of new skills or processes at one time. The shapes and methods of fabrication largely represent current Navy practices.

Work presented is that which an alert trainee may be expected to learn within approximately three hundred hours of pre-employment training. Jobs have been excluded which require greater experience than may be developed in a pre-employment training course.

It is necessary that a competent marine sheet metal instructor demonstrate the proper use of hand and machine processes, and critically inspect the work fabricated by trainees.

Appreciation is extended to the marine sheet metal foremen, mechanics, and draftsmen who assisted in determining training needs, in preparing the preliminary analysis, and in developing job sheets.

Special acknowledgment is made to the following persons: Joseph Kauffman, Master Mechanic, Sheet Metal Department, Philadelphia Navy Yard; Gasper Artale, Foreman, Sheet Metal Department, Cramp Shipbuilding Company; Ernest Cannon, Assistant Foreman, Sheet Metal Department, Cramp Shipbuilding Company; Edward Horne, Leadingman, Sheet Metal Department, Philadelphia Navy Yard; and Everett Halfhill, Mechanic, Sheet Metal Department, Philadelphia Navy Yard. Mr. Horne served as technical adviser and provided valuable assistance in the final editing of material.

The assistance of Charles L. Pierce, Walter J. Gogerty, Charles Campbell, Herman Kline, Charles Seel, and Fred Stetser, marine sheet metal instructors, School District of Philadelphia, Vocational Education for National Defense, is gratefully acknowledged. Mr. Pierce assisted with the preparation of instructions and preliminary sketches. The cooperation of supervisory personnel of the Mastbaum Vocational School and Annex is acknowledged.

Acknowledgment is made to Charles F. Bauder, Director of Vocational Education, and to William E. Brunton, Assistant Director in Charge of Defense Training, of the School District of Philadelphia, for cooperation and assistance in the development of this material.

The assistance of Edgar W. Glenn, Special Agent, U. S. Office of Education, Instructional Materials Section, is gratefully acknowledged.

This unit of instruction was prepared by the Philadelphia Field Curriculum Laboratory of the Pennsylvania Department of Public Instruction, under the direction of Charles F. Zinn, Adviser, Division of Industrial Education, with the assistance of Wayne W. Thompson, Adviser, Division of Industrial Education. This work was completed under the general supervision of Paul L. Cressman, Director, Bureau of Instruction, and Urwin Rowntree, Chief, Division of Industrial Education.

Francis B. Haas
Superintendent of Public Instruction

July, 1942

Introduction

The jobs presented in this suggested course in Marine Sheet Metal Shop Practice were selected by supervisors, foremen, and mechanics employed in marine sheet metal departments to represent the work which trainees may be expected to perform in this field. Careful consideration was also given to the type of work which a trainee may reasonably be expected to accomplish within a pre-employment training period.

Although the basic tool and machine processes are similar for sheet metal ventilation, whether for marine or general construction, methods of construction and weights of metals differ considerably. Marine shapes, particularly those for Navy application, involve factors of weight, space saving, strength, portability, damage control, stress under gun fire, etc., which materially influence the design and fabrication of these shapes. Alternate specification sketches and fabrication procedures are available for use in training expressly for cargo vessel construction.

It should be noted that pattern development has not been considered a required part of these jobs in sheet metal fabrication, rather it is intended that pattern development be employed as an aid in teaching fabrication processes and in developing a working knowledge of layout procedures. Where training requirements warrant, and the ability of the trainee permits, the instructor may, at his discretion, include as a mandatory requirement, development of the pattern for the shape specified in the job instruction sheet.

Shop practice in most marine sheet metal departments sharply segregates the development of sheet metal patterns from the laying out of the metal and fabrication of the job. "Layers-out" supply patterns; sheet metal shop workers receive these patterns, together with shop sketches and then proceed to fabricate the shapes. If the layer-out is busy or other conditions warrant, the shop worker may be required to develop patterns. However, the shop worker frequently lays out straight work from shop sketches, dimensions, diagonal measurements, or templates which he has secured.

In view of the future advancement which an alert trainee may anticipate, it is advisable that he learn to develop patterns for the jobs included in this series, even though shop practice would indicate that he will seldom be required to develop patterns. Through an understanding and working knowledge of pattern development procedures the trainee will be in a position to more readily assume responsibility in lifting, laying out, and in installing sheet metal work aboard ship.

In that many publishers can supply texts which present the operation and use of basic sheet metal tools and equipment, such material has not been included in this unit of instruction. Specific reference is made to the hand, machine, and lay-out sheet metal units prepared by the New York State Department of Education.

Units of instruction in marine sheet metal "field" work (work aboard ship) including "Sheathing and Insulation", "Bins, Shelving, and Lockers", "Light Metal Bulkheads", and "Ammunition Stowages" are available.

Contents

	Page
Safety Rules	1
Shop Rules and Regulations	2
Suggested Teaching Topic Units	3
Using a Power Machine	7
Suggested Shop Equipment for 20 Trainees	8
Suggested Shop Tools for 20 Trainees	9
Suggested Material for 20 Trainees	10
Job Instruction Sheets:	
Exercise A — Square Shear Blanks	11
Exercise B — Make Grooved Seams	13
Exercise C — Prepare Soldering Copper and Solder Seams	17
Job No. 1 — Fabricate Round Pipe with Riveted Seams	19
Job No. 2 — Fabricate Round Pipe with Grooved Seams	22
Job No. 3 — Fabricate a Fixture for a Circular Flange	24
Job No. 4 — Fabricate a 6″ Diameter N.W.T. to W.T. Flange	27
Job No. 5 — Fabricate a Flange Gasket and Grommets	32
Job No. 6 — Fabricate an Intermediate N.W.T. Circular Flange	36
Job No. 7 — Fabricate a Fixture for N.W.T. Rect. Flange	40
Job No. 8 — Fabricate a N.W.T. Rectangular Flange	42
Job No. 9 — Fabricate a Spool	45
Job No. 10 — Assemble Pipe Sections, and Fit to Spools	51
Job No. 11 — Fabricate Rectangular Duct with Double Seam, Pittsburgh Lock, and Slip Connection	56
Job No. 12 — Fabricate a Flat Slip	60
Job No. 13 — Fabricate a Joint of Flat Oval Pipe	63
Job No. 14 — Fabricate a 90 Degree T-Collar, Diameters Equal	66
Job No. 15 — Fabricate a 45 Degree Collar, Diameters Equal	69
Job No. 16 — Fabricate a 30 Degree Collar, Diameters Unequal	72
Job No. 17 — Fabricate a 45 Degree Circular Collar on Corner of Rectangular Duct	75
Job No. 18 — Fabricate a 45 Degree Shoe Collar, Diameters Unequal	78
Job No. 19 — Fabricate a Central Reducer	82
Job No. 20 — Fabricate an Off-Center Reducer, Round to Round	84
Job No. 21 — Fabricate a 30 Degree Collar on a Reducer	86

Page

Job No. 22 — Fabricate on Off-Center Rectangular Reducer 89
Job No. 23 — Fabricate a Double-Seamed Rectangular Elbow 91
Job No. 24 — Fabricate a Round Peened Elbow 94
Job No. 25 — Fabricate a Flat Oval Elbow 97
Job No. 26 — Fabricate a Central Rectangular to Round Transformer ... 100
Job No. 27 — Fabricate an Off-Center Flat Oval to Round Transformer .. 104
Job No. 28 — Fabricate an Off-Center Flat Oval to Rectangular Transformer 107
Job No. 29 — Fabricate a Rectangular Ogee Offset 110
Job No. 30 — Fabricate a N.W.T. Circular Offset 113
Job No. 31 — Fabricate a Five Piece Flat Oval N.W.T. Offset 116
Job No. 32 — Fabricate a Hanger 119
Job No. 33 — Drop Rectangular Elbow 123
Job No. 34 — Y-Branch 125
Job No. 35 — Assemble Shapes into Sub-Assemblies 127
Job No. 36 — Erect and Test Final Assembly 129
Reference A — Types of Sheet Metal 131
Reference B — Use of the Sheet Metal Gauge 132
Reference C — How to Lay Out a Welded Pipe—(Stretchout Dimensions) 135
Reference D — Layout for Pipe Having Small and Large Ends 136
Reference E — Description of Flanges 138
Reference F — Description of Rectangular Pipe Seams 146
Reference G — Double Seaming 147
Reference H — Pittsburgh Lock Seam 150
Reference J — Turning a Double Edge with a Turning Machine 152
Reference K — Electric Spot Welding 154
Reference L — How to Make a Spot Weld 156
Reference M — How to Make a Test Weld 158
Reference N — How to Operate the "Nibbling" Machine 160
Reference O — How to Make and Use Sheet Metal Markers 162
Reference P — How to Make a Joggle on the Cornice Brake 163
Reference Q — Closing a Peened Edge 165
Reference R — Air Test of Fume-Tight Vent Assemblies 166
Reference S — Shop Routing Procedure 168
References to Basic Hand and Machine Processes 169
General References 186

SAFETY RULES

1. Never use machines, tools or other equipment with which you are unfamiliar or which have not been specifically assigned to you.

2. Before using any machine, check to see if the machine is in safe operating order and that all safety devices are satisfactory. If any discrepancy is found report this fact to your instructor at once; he will take the necessary steps to correct the fault before allowing the machine to be used.

3. On work such as grinding, routing, drilling, welding, buffing, and chipping, where flying particles are present, the use of goggles or eyeshields as eye protective equipment is absolutely required.

4. All returned tools shall be inspected by the clerk in charge of the tool crib.

5. Be sure the power is turned off and the machine has come to a dead stop before adjusting, cleaning, or oiling a machine.

6. Never wear neckties, rings, or loose clothing while working on a machine.

7. Notify your instructor immediately if any mechanical or electrical equipment is in need of repairs. Never attempt to adjust or repair machinery unless you have been authorized to do so.

8. Never keep sharp pointed tools such as screw drivers, scribes, picks, etc., in your trousers or shirt pockets.

9. Keep floors free from slipping or tripping hazards. Do not allow tools to accumulate on benches. After use return tools to their proper place.

10. When drilling use a wood block to "back-up", particularly when drilling on ships or parts.

11. Check the cord and connections before using portable electric equipment.

12. Many injuries in the shop are due to "horseplay". This is absolutely forbidden at all times.

13. Be sure that tools or other objects may not be dislodged and fall, causing injuries to someone below. Tools should <u>not</u> protrude beyond the end or side of shelves or work benches.

14. See that the cut is made away from the body when using sharp-edged tools.

15. The tool rest must be set close to the wheel when operating a grinder. Clearance must not exceed 1/16 of an inch. Use only the face of a wheel when grinding.

16. When using an air hose for cleaning, be sure that particles do not fly toward your face, or toward another person. Where practical use hand brush.

17. Never use a tool or machine for any purpose other than that for which it was intended.

18. "Point of operation" guards must be used where humanly possible, on punch presses, square shears, abrasive wheels, and band saws.

SHOP RULES AND REGULATIONS

Sheet Metal

1. Edges of metal that have been cut with hand shears should be filed clean of slivers
2. Never see if burrs or slivers are present by rubbing fingers along edges of metal.
3. Do not attempt to hold metal by hand when drilling holes with the drilling press.

Band Saw

1. Keep hands at a safe distance from saw blades.
2. Never expose more of saw than is necessary.
3. While sawing, never remove throat.
4. Before turning on power, be sure that the height of the saw guide is adjusted.

Materials

1. Secure permission of instructor before cutting materials for your own use. Material must be issued by stock clerk or instructor. Be cautious in the use of material. Taxpayers are paying high prices for sheet metal. Make good use of it and avoid waste.
2. All materials issued and turned in shall be accounted for by instructor or stock clerk. Do not remove or discard any material.
3. Do not store rivets away in your tool kits as this causes a shortage. The stock clerk or instructor shall issue only the amount of rivets necessary for the project in operation.

Clean-Up

1. At the end of each period several floor sweepers assigned by the instructor shall thoroughly clean up the shop.
2. Before leaving at the end of class each student is responsible to see that his place is ready for the next student. The student should brush off the tops of the benches, wrap up air hoses, and see that his work area is clean.

Safety Precautions

1. Treat all injuries, scratches, or cuts immediately.
2. All safety rules pointed out in your lesson plans should be observed.
3. When using emery wheel always wear goggles.
4. It is your duty to report any hazards (equipment or personal) to your instructor.
5. Be alert for rough edges or splinters when handling sheet metal.

SHEET METAL WORKER

Suggested Teaching Topic Units for Course

A. Shop Instruction in Hand Processes

1. Marking Metal
   a. Securing and checking patterns and templates
   b. Transfering patterns (paper and metal)
      (1) Anchoring patterns
      (2) Scribing outlines
      (3) Center punching brake and other lines
      (4) Scribing holes
      (5) Recording identification and work symbols
   c. Laying out metal with and without aid of patterns or templates
      (1) Using steel square
      (2) Using combination square
      (3) Using straight edge
      (4) Using dividers and trammel points
   d. Scribing and slitting for notching
      (1) Making metal markers
      (2) Using metal markers

2. Cutting metal with left and right hand snips and bench shears
   a. Shearing and trimming
   b. Cutting circles
   c. Cutting holes
   d. Notching
   e. Cutting pipe and duct

3. Forming metal on stakes
   a. Forming square jobs
   b. Forming small diameters
   c. Forming conical items
   d. Forming wire & wire edge

4. Bending sheet metal on shop made forms and devices
   a. Bending a sheet at 90° angle
   b. Bending a sheet at any angle
      (1) Single hem
      (2) Double hem
      (3) Grooved seam.
   c. Bending a radius using a mold block

5. Filing sheet metal
   a. Rough and finish filing flat surfaces
   b. Filing round corners
   c. Deburr holes and filing short edges
   d. Cleaning files

6. Soldering
   a. Forging a soldering copper
   b. Filing a soldering copper

c. Tinning a soldering copper
d. Soldering a lap seam
e. Soldering a grooved seam
f. Soldering a riveted seam
g. Soldering an overhead seam

7. Grooving a seam
   a. Using a groover
   b. Outside grooved seam and inside grooved seam using a grooved mandrel
   c. Flat grooved seam

8. Using a chisel
   a. Grinding cutting edge
   b. Dressing "mushroomed" head
   c. Cutting sheet metal secured in vise
   d. Chipping
   e. Cutting flat stock

9. Dovetailing
   a. Making a marking gauge
   b. Making a dovetail
   c. Making a plated dovetail
   d. Making a flanged dovetail

10. Flanging an edge
   a. Flanging an edge on a stake
   b. Shrinking an edge on a stake
   c. Flanging an edge using a dolly

11. Punching holes in sheet metal
   a. Using solid punch
   b. Using hollow punch
   c. Using hand punch
      (1) Changing punch and die
      (2) Setting gauge
      (3) Punching to center marks

12. Drilling
   a. Using hand and breast drill
   b. Using portable drill
   c. Using spindle drill
   d. Sharpening drills

13. Hack Sawing
   a. Selecting, replacing, and adjusting a saw blade
   b. Using a hack saw
      (1) Cutting bar material
      (2) Cutting tubing

14. Riveting
   a. Using a rivet set
   b. Riveting a seam
   c. Using pneumatic hammer

15. Wiring
    a. Wiring straight piece of metal
    b. Wiring a radius on flat job
    c. Wiring a rectangular formed job
    d. Wiring a tapered formed job

16. Seaming
    a. Making a grooved seam
    b. Making a riveted seam
    c. Making a double seam - inside and outside
    d. Making a spot welded seam
    e. Making a Pittsburgh Lock seam
    f. Making a welded seam

B. Shop Instructions in Machine Processes

1. Bar folders
    a. Setting, adjusting and operating machine to form:
        (1) Single hem
        (2) Double hem
        (3) Grooved seam
        (4) Rounded fold for wire
        (5) Angle fold
        (6).Double right angle fold
    b. Maintaining machine

2. Cornice brake
    a. Setting, adjusting and operating machine to form:
        (1) Sharp brakes
        (2) Rounded brakes
        (3) Molds
        (4) Pittsburgh lock
    b. Maintaining machine

3. Slip roll forming machine
    a. Setting, adjusting and operating the machine to form:
        (1) Cylindrical shapes
        (2) Tapered shapes (operation skill)
        (3) Cylindrical shapes with wire reinforcing
        (4) Two rods
    b. Maintaining machine

4. Squaring shears
    a. Setting, adjusting and operating machine to:
        (1) Square a sheet
        (2) Cut to mark
        (3) Cut a sheet, using front gauge
        (4) Cut a sheet, using back gauge
        (5) Cut a sheet, using angle gauge
    b. Maintaining machine

5. Beading machine
    a. Setting, adjusting and operating machine to make:
        (1) Single bead

(2) Ogee bead
(3) Triple bead
b. Maintaining machine

6. Crimping machine
a. Setting, adjusting, and operating machine to:
(1) Crimp edges
(2) Crimp and bead edges
b. Maintaining machine

7. Ring and circular shears
a. Setting, adjusting and operating shears to:
(1) Cut a circle or disc
(2) Cut rings
(3) Slit sheet metal
(4) Make irregular cuts
b. Maintaining machine

8. Turning machine
a. Setting, adjusting and operating machine to:
(1) Turn and flange an edge
(2) Turn an edge for wiring
b. Maintaining machine

9. Burring machine
a. Setting, adjusting and operating machine to:
(1) Burr an edge on a disc
(2) Burr an edge on a body
b. Maintaining machine
c. Making and using hand guard

10. Grinder
a. Selecting and mounting wheels
b. Dressing grinding wheels
c. Grinding tools
d. Maintaining grinders

11. Power metal saws
a. Band saw
(1) Sawing soft sheet metal
(2) Sawing tubing
(3) Maintaining machine
b. Hack saw
(1) Sawing structural steel
(2) Sawing bar stock
(3) Maintaining machine

12. Spot Welder

13. Nibbling Machine

14. Power Brake

15. Unishear

SPECIAL CONSIDERATIONS WHEN USING A POWER MACHINE

Subject: Special considerations in laying out, marking, and fabricating when a power machine is to be used.

Power shear: Special considerations.
1. Proper marking.
   a. Indicate degree bands.
   b. Provide stay for bender.
   c. Center punch bend mark.
   d. Brake symbols.

Punch press: No special considerations.

Nibbler: Special considerations.
1. Indicating center of work.
2. Indicating punch mark for $\frac{1}{2}$ diameter of nibbler punch.
   a. Cleaning work from nibbler.

Angle roll: Special considerations.
1. Allowance for extra length. Work after rolling must be cut to fit diameter.
   Note: Extra length is necessary in that the construction of the machine does not permit exact shaping of starting and finishing ends of angle being rolled.

Grinders: Special considerations.
1. Safe practices.
2. What not to grind—light sheet metal, solder and lead.
3. Grinder is not to be used in place of shears.
4. Grinder to be used for heavy material, tools and angle irons.
5. Types of grinders used
   a. Pedestal—floor—stationary.
   b. Portable unit type
   c. Portable unit type.
   d. Flexible shaft.
   e. Buffer and wire brush.

Saws: Special considerations.
1. Do-all type (band saw).
   a. Close center punching so that operator can follow line.
   b. Do not use soapstone as mark for saw operator.
   c. Blank out piece slightly larger than finished size so that operator will not be required to handle large sheets.
   d. Duplicating pieces by tack welding several sheets together.

SUGGESTED SHOP EQUIPMENT FOR SHEET METAL SHOP FOR TWENTY TRAINEES

POWER MACHINERY:

1 Drill Press - single spindle, capacity 1/2" shaft
1 Drill - Portable Electric, 1/2" capacity complete with mounting bracket
1 Grinding Machine - 1800 R.P.M., 2"x8" wheel, double end, complete with guards
1 Grinding Machine - 3000 R.P.M., 3/4"x6" wheel, " " " " "
1 Nibbling Machine
1 Spot Welding Machine - Electric

SHOP EQUIPMENT:

2 Anvils - 8" Horn
1 Brake - Box Folding 48"
1 Brake - 48" - Cornice
1 Brake - 96" - Cornice
1 Beading Machine
1 Block - Straightening - 3/4"x48"x48"
1 Crimping and Beading Machine
24 Drawing Boards - 36"x24"
1 Elbow Edging Machine
1 Forming Machine - Slip Roll 2" x 30"
1 Forming Machine - Slip Roll 1-1/2"x36"
1 Folding Machine - Bar - 48"
15 Furnaces - Gas - Double Burner
4 Plates - Bench - 31"x8"
2 Punches - Hand Bench - Large
1 Punch - Hand - Large
2 Punches - Hand - Small
1 Shear - Hand Lever
1 Shear - Hand Rotary
1 Shear - Squaring - 36"
1 Shear - Squaring - 30"
1 Shear - Throatless (Similar to Beverly type)
2 Stakes - Beak Horn
4 Stakes - Bench, Edge Square - 2-1/2"x 4-1/2"
4 Stakes - Bevel Square - 3"x5"
2 Stakes - Blow Horn
6 Stakes - Conductor 2"
4 Stakes - Coppersmith - 3"x5"
2 Stakes - Hatchet 10"
2 Stakes - Hatchet 13"
2 Stakes - Hollow Mandrel - 4"
1 Stake - Needle Case
2 Stakes - Round Head - 2" diam.
2 Stakes - Solid Mandrel
4 Stakes - Square - 3"x5"
1 Setting Down Machine
1 Swaging Machine
2 Tables - Detail and Layout 10' x 4'
10 Tables - Work - 10'x 38"
3 Turning Machines - Small with Wiring and Burring Wheel Attachments
6 Vises - Machinists - 3" jaws
12 Vises - Machinists - 6" jaws
Bins, Lockers and Storage facilities

SUGGESTED SHOP TOOLS FOR SHEET METAL SHOP FOR TWENTY TRAINEES

60		Blades for Hack Saw - 24"
6		Chisels - 6" Cape
12		Chisels - Flat - 1/2"x6"
12		Chisels - Flat - 3/4"x6"
12		Dividers - 6"
6		Dividers - 10"
20		Drawing Triangles - 30° - 60°
20		Drawing Triangles - 45°
10	Sets	Drills - Twist - up to 1/2" by 32nds.
12		Files - Assorted - with Handles
2		Gauges - U. S. #2 Wire and Sheet Metal
12	Sets	Grooving Tools - 1/8" to 5/16"
12		Hack Saw Frames - 24" Adjustable
12		Hammers - Ball Peen - 10 oz.
6		Hammers - Raising - 32 oz.
10		Hammers - Riveting - 8 oz.
10		Hammers - Setting - 8 Oz.
24		Handles - for Soldering Copper
20		Mallets - Composition - 2-1/2"x5-1/2"
10		Mallets - Rawhide (preferred) or Composition - 2"x4-1/2"
2		Nippers - Square Edge - 8"
15	Prs	Pliers - 8" Side Cutting
6	Prs	Pliers - 6" Combination
6		Punches - Center
6	Sets	Punches - Hollow - 1/4 to 1-1/4
6		Punches - Prick
12	Sets	Rivet Sets - 12 oz. to 5 lbs.
6		Rules - Flexible Steel - 6'
10		Rules - Steel - 13"
6		Scrapers - Plumbers
12		Screw Drivers - 10"
10		Scribers
12	Prs	Shears - Aviation - 8"
1	Pr	Shears - Bench - 8"
6	Prs	Snips - Circular - 4" Blades
4	Prs	Snips - Hawk's Bill - 2-1/2" Cut
15	Prs	Snips - Straight - 4" Blades
20	Prs	Soldering Coppers - 2 lb.(1 lb each)
20	Prs	Soldering Coppers - 3 lb. (1-1/2 lb each)
6		Squares - Combination - 12"
6		Squares - Framing - 24"
2		Straight Edges - 10"
20		T Squares - 24"
6	Sets	Tap and Dies
1	Set	Trammel Points

SUGGESTED MATERIAL FOR SHEET METAL SHOP FOR TWENTY TRAINEES

50	Feet	M.S. Galvanized Bar Stock - 1"x1/8"
1	Sheet	Galvanized Sheet Steel - 3'x8' - #14
14	Sheets	Galvanized Sheet Steel - 3'x8' - #16
10	Sheets	Galvanized Sheet Steel - 3'x8' - #18
13	Sheets	Galvanized Sheet Steel - 3'x8' - #20
21	Sheets	Galvanized Sheet Steel - 3'x8' - #22
28	Sheets	Galvanized Sheet Steel - 3'x8' - #24
1	Piece	1/8"x1'x5' Galvanized Steel
5	Sheets	Black Sheet Steel - 3'x8' - .125
5	Sheets	Black Sheet Steel - 3'x8' - .187
4	Sheets	1/8" Gasket Material - 3'x3'
5	Lbs	Tinners Rivets - 1 lb
5	Lbs	Tinners Rivets - 1-1/2 lb
4	Lbs	Tinners Rivets - 2 lb
4	Lbs	Tinners Rivets - 2-1/2 lb
4	Lbs	Tinners Rivets - 3 lb
3	Lbs	Tinners Rivets - 4 lb
3	Lbs	Tinners Rivets - 5 lb
3	Lbs	Tinners Rivets - 6 lb
2	Gross	Machine Screws & Nuts - 3/8"x1"
2	Gross	Bolts, Nuts & Washers - 3/8"x1"
2	Gross	Machine Screws - 1/4"-20x1" - Steel Cad.
2	Gross	Sheet Metal Screws 1/2"-10/R.H.
15	Lbs	Half and Half Solder
2	Quarts	Muriatic Acid
50		Acid Swat Brushes
10		Bricks - Sal Ammoniac
12	Pcs	Emery Cloth - 360
12	Pcs	Emery Cloth - 180
12	Pcs	Emery Cloth - 50
2	Lbs	Wicking for Grommets

SQUARE SHEAR BLANKS

Objectives:

1. To learn how to use a metal gauge.
2. To become familiar with various gauges of sheet metal.
3. To learn how to operate a square shear.

General Information:

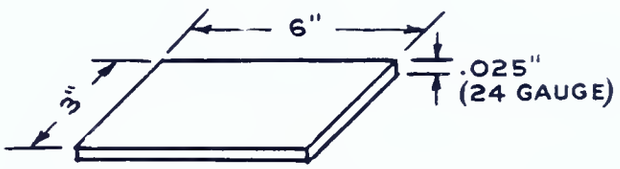
The fabrication of this apparently simple job involves a great many steps with which the trainee is not familiar, and since there is much information of a preliminary nature which must be mastered, this job has been subdivided and presented in less complicated parts or steps. Each subsequent step requires the materials fabricated in the preceding job.

The trainee should thoroughly understand each step and be capable of applying the information presented before he proceeds to the next job or lesson. The study of the instruction sheets and references outside of shop hours is strongly recommended.

Shipyards are equipped with the power-shear, and use this type of equipment very extensively. Few school shops have this machine available. However, in that the principles of operation of these two machines are similar, the trainee will be in a position to learn fundamentals of shear operation on the foot power type of equipment. Since the capacity of a foot power-shear is limited, the trainee must be careful not to exceed the rated cutting capacity of this machine.

Specifications:

1. Five pieces of 24 gauge (.025) galvanized sheet steel, 3" x 6". Fig. 1)



REQUIRED SINGLE BLANK

Tools needed:

1. Sheet metal gauge
2. Rule

Equipment needed:

1. Square shear

Materials needed:

24 gauge galvanized sheet steel

Procedure:

1. From scrap select sufficient 24 gauge galvanized sheet steel to cut five blanks, each 3" x 6". See Ref. B.

Good shop practice requires that a workman utilize scrap metal when available. Always look through scrap for metal before requisitioning full sheets. If scrap can not be found, secure the permission of your instructor or foreman to use stock.

In shipyards, workers are expected to use metals economically. The shipyard worker who must obtain stock for a job consults his leadingman or foreman, who authorizes a requisition for the required stock. This requisition is presented to the person in charge of "shop stores", where the required material is issued to the workman.

2. Square Shear Blanks

Caution: Do not operate square shear until you have received directions from your instructor. This applies to all machines in the shop. NEVER allow your fingers to come under the shear blade.

Detailed information concerning operation of the square shear is given in Reference list. Study these sheets carefully, as directed by your instructor.

References:

1. See Reference List for Exercise A.
2. Reference A—Types of Sheet Metals
3. Reference B--Standard U. S. Gauges of Sheet Metal

Questions:

1. What keeps the metal from slipping while it is being sheared?
2. When should you use a "front gauge"?
3. If the metal thickness is stated as a decimal, how can you determine what the gauge number will be?
4. What determines the smallest width that can be trimmed from a sheet?
5. Describe two ways of cutting on a marked line.

MAKE GROOVED SEAMS

Objectives:

1. To learn how to use the cornice brake and the bar folder.
2. To learn how to use a hand groover.
3. To learn how to make allowance for grooved seams.

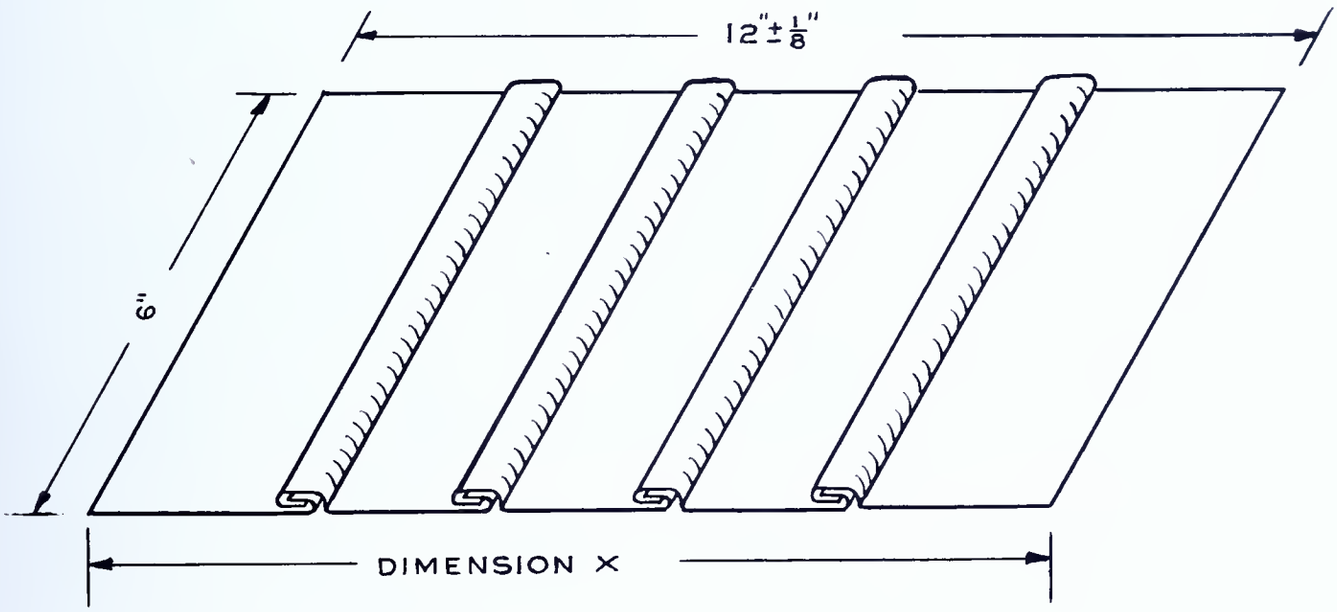
General Information:

Grooved seams are usually used on sheet metals of 20 gauge and lighter. The use of the grooved seam eliminates the necessity of riveting, and also produces a relatively fume-tight joint without soldering. In laying out for a grooved seam, care must be exercised in making proper allowance for grooving, keeping in mind the number of size of the groover and the gauge of metal used.

Brake lines must be accurately laid out and fabricated, and care exercised in grooving. Careful workmanship is necessary to secure a square job when many groove seams are to be made.

Specifications:

The five 3" x 6" sheet steel blanks which were sheared in Exercise A are to be seamed together, along their 6" dimensions, by means of grooved seams; use a No. 2 hand groover.



EXERCISE B.— GROOVED SEAMS

Tools needed

1. No. 2 groover
2. Riveting hammer
3. Mallet
4. Scriber
5. 6" or 12" steel scale
6. Center punch
7. Steel square

Equipment needed

1. Cornice brake
2. Bar folder
3. Hollow mandrel

Materials

Five sheared blanks, 24 gauge (.025) galvanized sheet steel, size 3" x 6". (This material was prepared in Exercise A)

Procedure:

1. Lay out bend lines on blanks, as illustrated in Fig. 1.

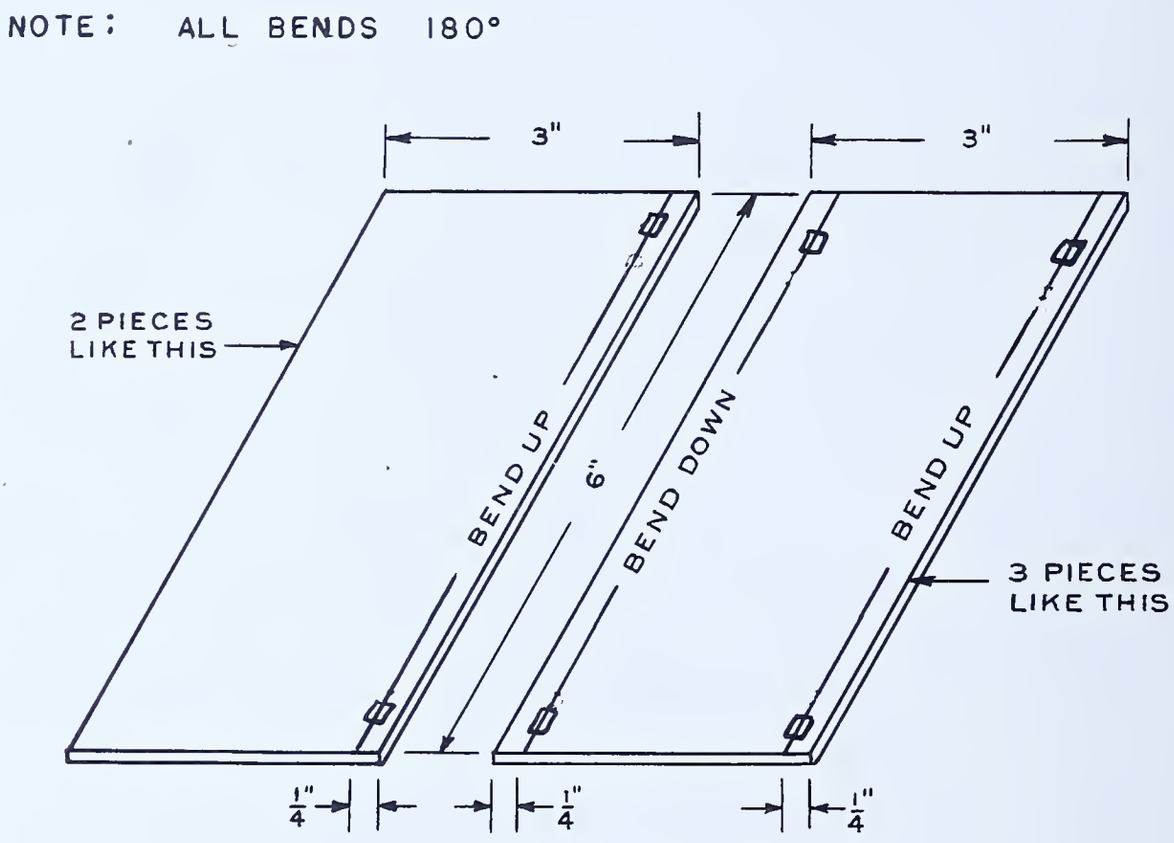


FIGURE 1 — MARKED SHEETS

2. Center punch bend lines.
   Punch marks may be placed about 3/4" in from ends of bend line. (This is not a measured distance.)

3. Bend edges of blanks as laid out, using a cornice brake or bar folder.
   In bending short pieces, the bar folder is more convenient to use than the cornice brake. The bar folder can be set to readily duplicate folds.

4. Hook the first two pieces together and groove the seam with a No. 2 groover, as shown in Fig. 2. See Reference for Exercise B for procedures used in making a grooved seam.

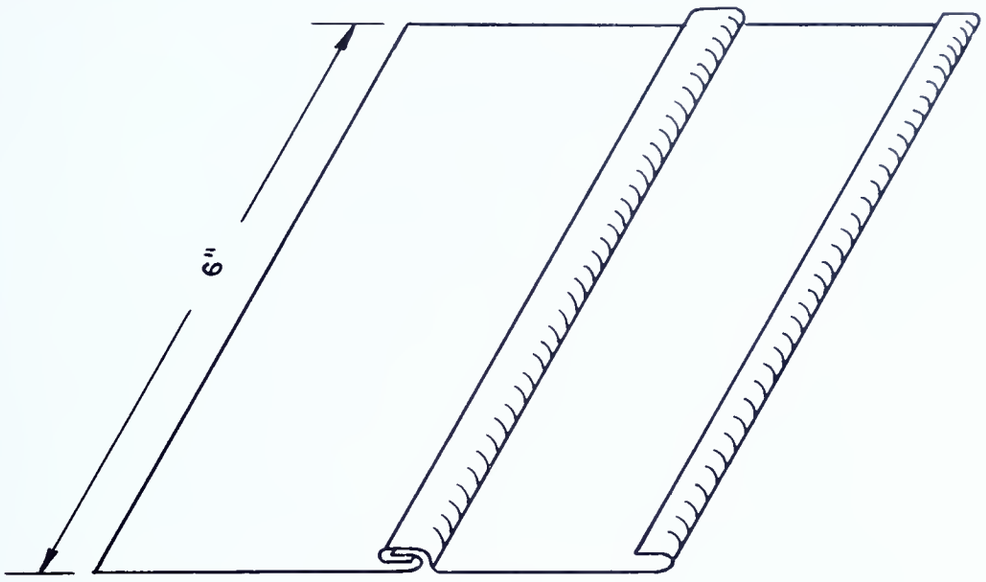


FIGURE 2 — FIRST TWO PIECES GROOVED TOGETHER

5. As shown in Fig. 3, assemble and groove remaining pieces.

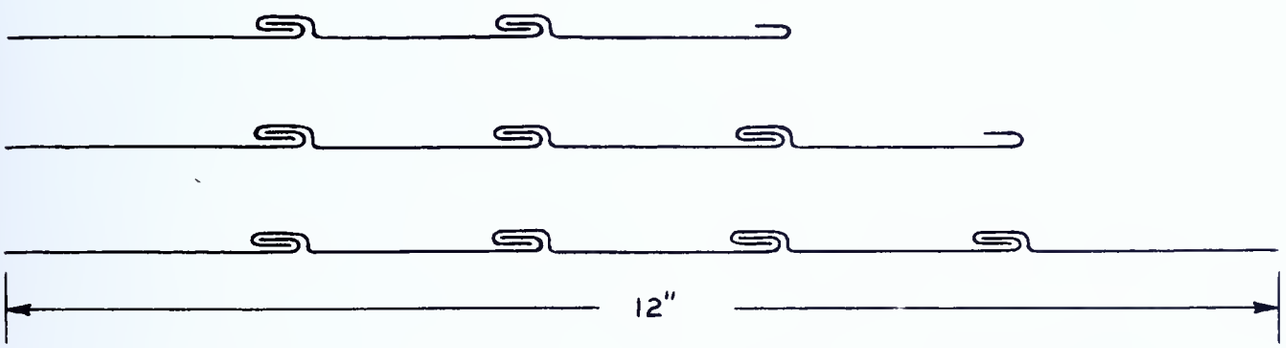


FIGURE 3 — ORDER IN WHICH REMAINING PIECES ARE GROOVED TOGETHER

References:

1. See Reference List for Exercise B.

Questions:

1. What does dimension "X", in Specification illustration measure?

2. What was the total length of the five blanks (dimension "X"), before their edges were folded for grooving?

3. Why is dimension "X" in question "1" less than dimension "X" in question "2"?

4. What would dimension "X" be if you had used 22 gauge and a No. 0 groover? What would the measurement have been for the fold?

5. How are allowances for goooved seams determined?

6. Give three methods of "locking" a grooved seam?

PREPARE SOLDERING COPPER AND SOLDER SEAMS

Objectives:

1. To learn how to forge, file and tin a soldering copper.
2. To learn how to solder seams.

General Information:

Marine sheet metal ventilation work is either fume-tight or watertight. In that most jobs in this series would be classified as fume-tight, it is necessary that all seams and rivets be soldered.

Soldering is an important part of the training of the marine sheet metal worker; he must learn to do this job well. Soldering must be done from flat, vertical and overhead partitions. It is strongly recommended that the trainee practice soldering jobs indicated in this series from these several positions. Attention is directed to the special preparation of soldering coppers for overhead soldering. Solder is applied on only one side of the copper for overhead work.

Edges which are not newly sheared must be cleaned with scraper or file before flux is applied.

Specifications:

1. Seams to be sweat-soldered with half-and-half solder.

Tools Needed:

1. Soldering coppers, (two, size 3 lb)
2. Riveting hammer
3. Ball peen hammer
4. 10" file

Equipment Needed:

1. Gas Furnace

Materials Needed:

1. Solder 50/50
2. Salamoniac
3. Muriatic acid or specified flux
4. Seamed blanks (as prepared in Exercise B)

Procedure:

1. Write a requisition and secure from tool booth the above mentioned tools.
2. Light the gas furnace.
3. Place one of the soldering coppers in the furnace and heat it to a cherry red.
4. Forge, file, and tin the tip. See References for Exercise C.
5. Repeat step "4" with the second soldering copper.

Note: While you are preparing the first soldering copper, the second soldering copper may be placed in the furnace to heat.

6. Solder the grooved seams of Exercise B as shown in Fig. 1.

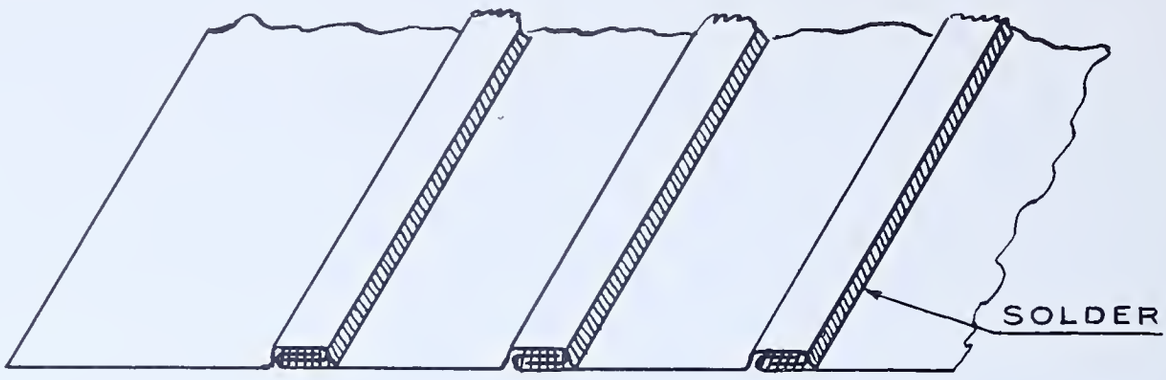


FIG. 1 — SOLDERED SEAMS

7. Wet a clean piece of waste with clean water and wipe off all soldering flux while work is warm (but not hot). Wipe dry with clean waste.
8. Clean file before returning it to tool booth. See Reference for Exercise C.

References:

1. See References for Exercise C.
2. Broemel, "Methods of Soldering" page 180.

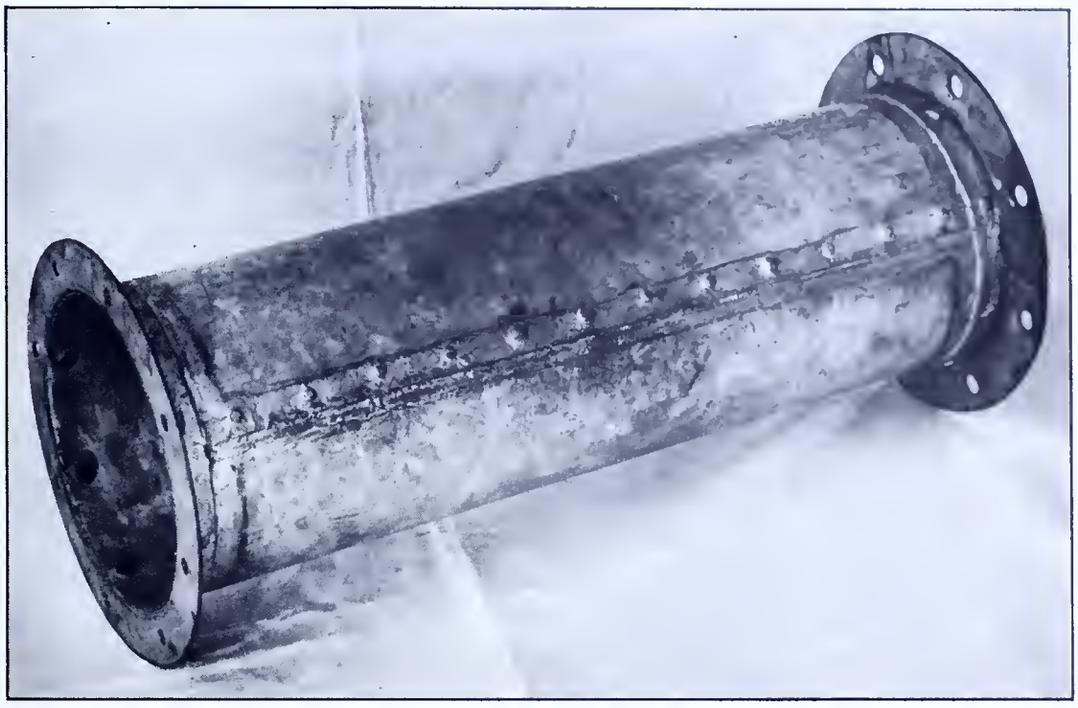
Questions:

1. Name four ways in which heat may be applied to soldering coppers. Which three are used for outside work? Which two are used for inside work?
2. What must be done to a soldering copper before solder will adhere to it?
3. What happens if you overheat a soldering copper that has been tinned?
4. What is the actual weight of the head of a "five-pound" soldering copper?
5. What chemical compound is used to clean the tip of a soldering copper so that solder will adhere to it?
6. Indicate three ways of cleaning a hot soldering copper just prior to soldering.
7. Name the metals in sheet metal solders and percentage of each.
8. Why is pure or "block" tin used in soldering some jobs?
9. What is the trade name of zinc chloride?
10. How is zinc chloride prepared?
11. On what type of sheet metals is zinc chloride used as the flux?
12. What fluxes are used when soldering stainless steel?
13. What fluxes and solders are used to solder aluminum?

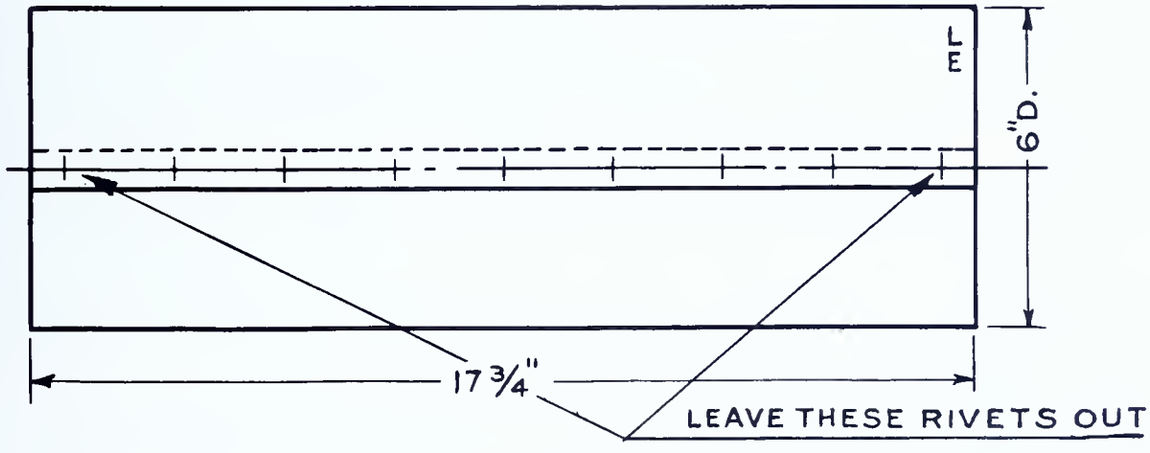
FABRICATE ROUND PIPE WITH RIVETED SEAM

Objectives:

1. To learn how to develop a pattern for a joint of pipe.
2. To learn how to make allowances for large and small ends of pipe
3. To learn how to fabricate a joint of pipe.
4. To learn how to use slip rolls.
5. To learn how to lay out a pipe with a riveted seam.
6. To learn how to rivet seams.
7. To become familiar with different sizes and spacing of rivets.



ROUND PIPE WITH RIVETED SEAM
AND FLANGES



JOB 1 — ROUND PIPE RIVETED

General Information:

Riveted seams and joints are frequently used in fabricating fume-tight pipes. Fume-tight pipes, whose seams are soldered, are made from galvanized steel rather than black steel. The thickness of material for fume-tight pipe is from 20 to 16 gauge sheet metal. If an attempt is made to rivet metal lighter than 20 gauge there is a tendency of the metal to stretch and buckle between the rivets. Therefore a grooved seam is used in metal of lighter than 20 gauge. A heavier gauge metal is used in fabricating water-tight pipes with seams and joints welded.

Specifications:

1. Diameter 6".
2. Length, 17-3/4".
3. Gauge, 20 (.038) galvanized sheet steel.
4. Seam, riveted and soldered.
5. Linear seam lap, 3/8" (3/4" landing).
6. End lap 1/2" (1" landing).

Tools Needed:

1. Metal gauge
2. Scriber
3. Center punch
4. Rule
5. Square
6. Straight hand shear
7. Mallet
8. Riveting hammer
9. Rivet set No. 5
10. Soldering coppers (2)
11. Hand punch No. 5

Equipment needed:

1. Square shears
2. Slip roll
3. Mandrel or rail
4. Gas furnace

Materials needed:

1. One piece of 20 gauge (.038) galvanized sheet steel at least 17-3/4" x 21".
2. Tinners' rivets, size 2-1/2 lb.
3. Bar solder, half and half.

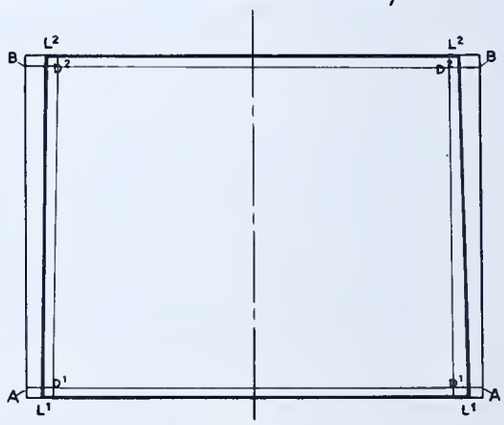


FIG. 1

Procedure:

1. Square shear metal to 17-3/4" x 21".
2. Place metal on work bench with long side (the stretchout) toward you.
3. Scribe a 1/2" margin A-A (the end lap line across this long side). Fig. 1.
4. Draw a line B-B parallel to line A-A, 16-3/4" from it.
5. Establish the mid-point of line A-A.
6. Erect a perpendicular to lines A and B, (℄) from this mid-point.
7. Calculate the circumference of a small end of pipe for this job. Reference D.
8. Calculate the circumference of the large end. Reference D.
9. From the mid-point of line B-B lay off (D^2-D^2) one-half the circumference of the small end each side of ℄.

10. From mid-point of line A-A lay off D^1-D^1 one-half the circumference of the large end.
11. Connect points D^1 and D^2 by lines drawn to the end.
12. Space line D^1-D^1 for rivet holes. Approximately 2-1/2" centers. These spaces must be exactly equal. Process is by trial and adjustment with the dividers. Fig. 2.
13. Space out rivet holes on D^2-D^2 using same procedure. (Naturally, these spaces slightly smaller.)
14. Space off rivet holes on margins D^1-D^2 in similar fashion.
15. Draw 3/8" specified linear lap lines L^1-L^2 on outside of D^1-D^2. See Fig. 2.
16. Shear on these lines.
17. Notch small end as N in Fig. 2.

    NOTE: It is common practice to notch the small end of pipe so that the person assembling the work may readily determine which is the large end. The notch serves no structural purpose; it is merely an identification.

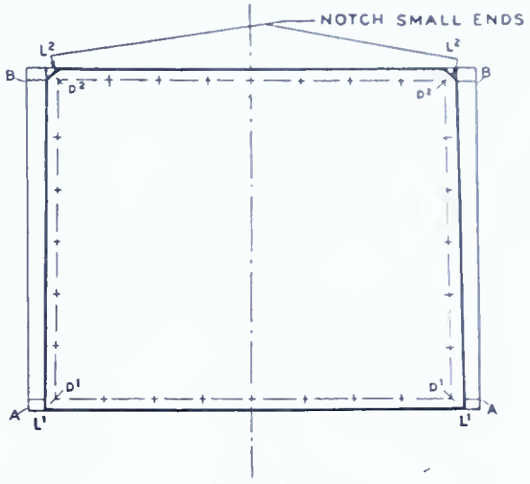


FIG. 2

18. Center punch rivet holes.
19. Punch rivet holes 3/16" diameter.
20. Form on roller.
21. Rivet, omitting the end rivets.
22. Solder seams.
23. Rinse off all remains of flux with water and wipe dry with waste.

References:

1. See References for Job 1.
2. Reference C — "How to Lay Out a Welded Pipe (Stretchout Dimensions)".
3. Reference D — "Layout for Pipe Having Small and Large Ends".

Questions:

1. What is the difference between a "punch" and a "die"?
2. What is the capacity of the No. 5 Hand Punch?
3. How are holes marked in layout work?
4. On what basis is the "pound size" of rivets calculated?
5. Why are rivets tin coated?

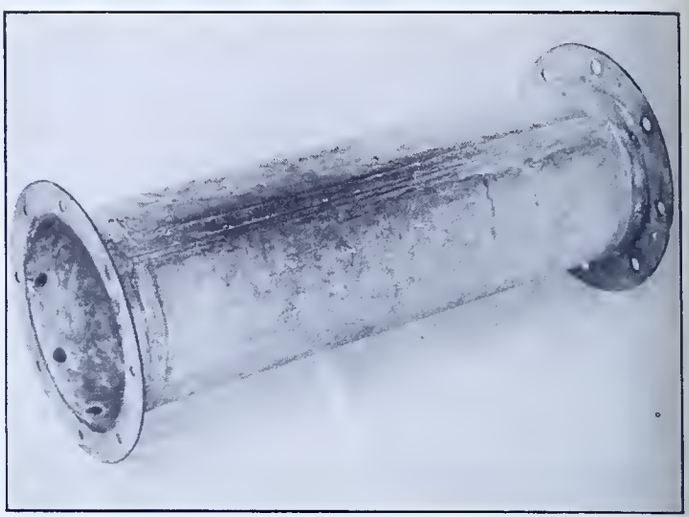
FABRICATE ROUND PIPE WITH GROOVED SEAM

Objectives:

1. To learn how to lay out a pipe with a grooved seam.
2. To learn how to lay out a joint of pipe from a pattern.
3. To learn how to groove seams.

General Information:

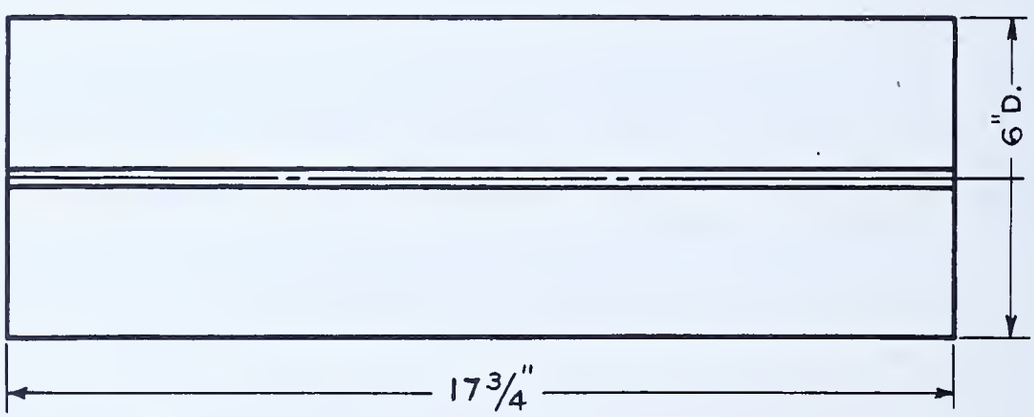
The fabrication of straight runs of pipe requires that certain layout procedures be employed. Aboard ship all straight runs of pipe are attached by means of flanges. Between flanges, pipe joints are riveted and soldered, for fume-tight work. If a run of pipe is to be water-tight, the sections will be welded together, but for handling purposes a flange is inserted at least every 8 ft. in any run of pipe.



ROUND PIPE WITH GROOVED SEAM AND FLANGES

Specifications:

1. Dimensions, 6" diameter x 17-3/4" long.
2. Seams, grooved and soldered.
3. Rivet spacing, joint, approximately 2-1/2" to centers.
4. Rivet landing, joint 3/4".
5. Metal, 24 gauge (.025) galvanized sheet steel.
6. Lap standard method (linear 3/8", end 1/2").



JOB NO. 2 ROUND PIPE—GROOVED

Tools needed:

1. Scriber
2. Rule
3. Straight shear
4. Groover (No. 2)
5. Mallet
6. Center punch
7. Soldering coppers (2)
8. Metal gauge
9. Riveting hammer
10. Hand punch (No. 5)

Equipment needed:

1. Square shear
2. Brake
3. Stakes
4. Gas furnace

Materials needed:

1. One piece of galvanized steel, 24 gauge (.022), at least 17-3/4" x 21" square.
2. Bar solder.
3. Muriatic Acid.

Procedure:

1. Study specifications and secure pattern for job.
2. Select scrap or stock metal of required gauge which is sufficiently large for the job.
3. Determine blockout dimensions from pattern and square shear metal accordingly A method of calculating these dimensions is shown in Reference D and Job 1.
   NOTE: Grooving "uses" more seam-lap allowance, therefore add 1/32" more on each side than for riveted lap lines. (Job 1). Sides of pattern are not parallel.
4. Transfer pattern to metal.
5. Lay-out and center punch brake lines for folds, or set gauge on folder brake.
6. Notch small end.
7. Punch 5/32" diameter rivet holes with hand punch.
   NOTE: The exact number of holes to be punched will be determined by specified rivet spacing.
8. Fold edges to be grooved on brake or bar folder.
   CAUTION: Turn one up and one down.
9. Form pipe to correct diameter on the slip roll.
10. Assemble the pipe by interlocking formed seams.
11. Groove seam on stake or hollow mandrel using the right size groover, hooking ends first for security.
12. Check both ends of pipe for roundness and specified dimensions.
13. Solder seam.
14. Rinse off all remains of flux with water and wipe dry with waste.

References:

1. See References for Job 2.
2. Job 1. "Fabricate Round Pipe with Riveted Seam".
3. Reference D — "Layout for Pipe Having Small and Large Ends".

Questions:

1. What is the decimal thickness of 24 gauge? Change this decimal to a fraction whose denominator is 32.
2. What would the stretchout dimension be if this job had been fabricated for 16 gauge (.062) metal?

FABRICATE A FIXTURE FOR A CIRCULAR FLANGE

Objective:

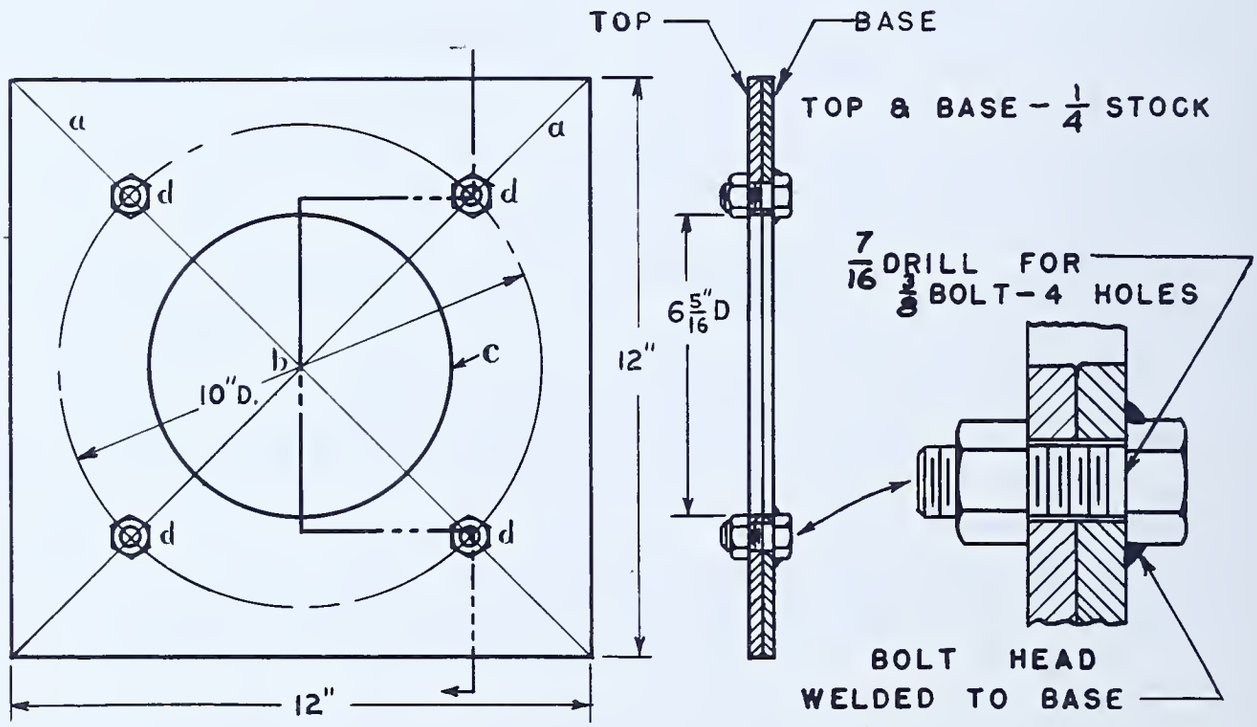
1. To learn how to make a flanging fixture.

General Information:

FLANGE FIXTURE

Jigs and fixtures are custom tools. By custom tool is meant a tool made to order for aiding in performing operations that cannot be accomplished by the use of standard tools. Reduction of cost through more rapid as well as more accurate manufacturing is made possible by their use.

There is a tendency to confuse the two terms, jigs and fixtures. The word jig is the more often used, and invariably, it is used in place of the word fixture. It may be said that a jig is a device that holds or is held on the work, and at the same time contains a means for guiding cutting tools, whereas a fixture holds or fixes the position of the work, while tools are in operation. The terms are controversial and the better mechanic will find it to his own advantage to adopt the terms as well as the customary practices of the shop in which he is employed.



JOB 3 — FIXTURE FOR N.W.T. TO W.T. FLANGE

Specifications:

1. Fixture to be made from hot rolled or cold rolled steel stock, 1/4" thick.
2. Four steel screws and nuts to be provided as a means of clamping.
3. Heads of screws to be arc welded to one side of fixture.

Tools needed:

1. Tape rule
2. Carpenters' square
3. Center punch
4. Riveting hammer
5. Scriber
6. 6" dividers
7. Drill, 7/16 diam.
8. O. E. (open end) adjustable wrench
9. Half round file

Equipment needed:

1. Nibbling machine

Materials needed:

1. Metal: Two pieces 1/4" (.250) MS (Mild Steel) stock approximately 12" x 12'
2. Four 3/8-16 x 1 steel machine screws.
3. Four 3/8-16 steel hex nuts.

Procedure:

1. Study specifications of job.
2. Select scrap or stock metal of required thickness.
3. Lay out on the metal, two squares 12" x 12", using a carpenters' square and scriber.
4. Center punch the lines, spacing the punch marks about one inch apart.
5. Deliver metal to burner and have him burn out the pieces along the center punched lines.
6. Knock-off with the tapered end of riveting hammer the crust of metal left along the edges by the burning operation.
7. Scribe the two diagonal lines, "a" (Specification Sketch) on the surface of both plates.
8. Center punch the point made by where the two diagonal lines intersect, "b".
9. Set a pair of dividers equal to 3-5/32" and with "b" as a center scribe the circumference line, "c", making a circle whose diameter will be 6-5/16". (Assuming flange is 16 gauge metal.)
10. Set the dividers equal to 5" and with "b" as a center scribe arcs intersecting the diagonal lines "a" at four places, "d".
11. Center punch the points "d".
12. Drill or punch 7/16" diameter holes through the center punched marks "d".
13. Cut out the center hole circle "C" to (6-5/16" diameter) and round off edges to a 1/16" radius.
    NOTE: This is usually done on the nibbling machine in the sheet metal shop, providing the capacity of the nibbler is sufficient to allow the cutting of 1/4" (.250) M.S. plate. (See Ref. N). If the hole is cut on a nibbler, dress the hole and turn the edge to a 1/16" radius with a file. It may also be done on "fly" cutter in drill press, or on the lathe in machine shop.
14. Place the two plates together and pass a 3/8" bolt through each of the four 7/16" diameter holes. Keep the bolt heads on the same side.

15. Screw on the nuts and tighten them evenly with an adjustable open end wrench.
16. Arc weld the heads of the bolts to the plate. The fixture is then ready for use. See Job 4 for procedures concerning the use of this fixture.

References:

1. Reference E — Description of Flanges.
2. Job Sheet 4 — Fabricating a N.W.T. to W.T. Flange.
3. Reference N — "How to Use the Nibbling Machine".

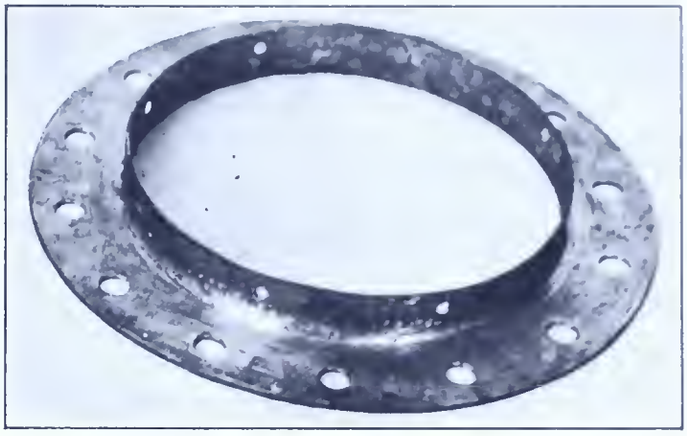
Questions:

1. What does the abbreviation M. S. stand for?
2. What is the complete meaning of the number "3/8-16 x 1" when it refers to a machine screw?
3. Why is it necessary to center punch a scribed line laid out for a burner to follow?
4. Why are the heads of the bolts welded to the fixture?
5. Explain the difference between a jig and a fixture.

FABRICATE A N.W.T. TO W.T. FLANGE

Objectives:

1. To learn how to fabricate a N.W.T. to a W.T. flange.
2. To learn how to lay out metal for making a flange.
3. To learn how to cut an inside hole on the nibbling machine.
4. To learn how to use a flanging fixture.



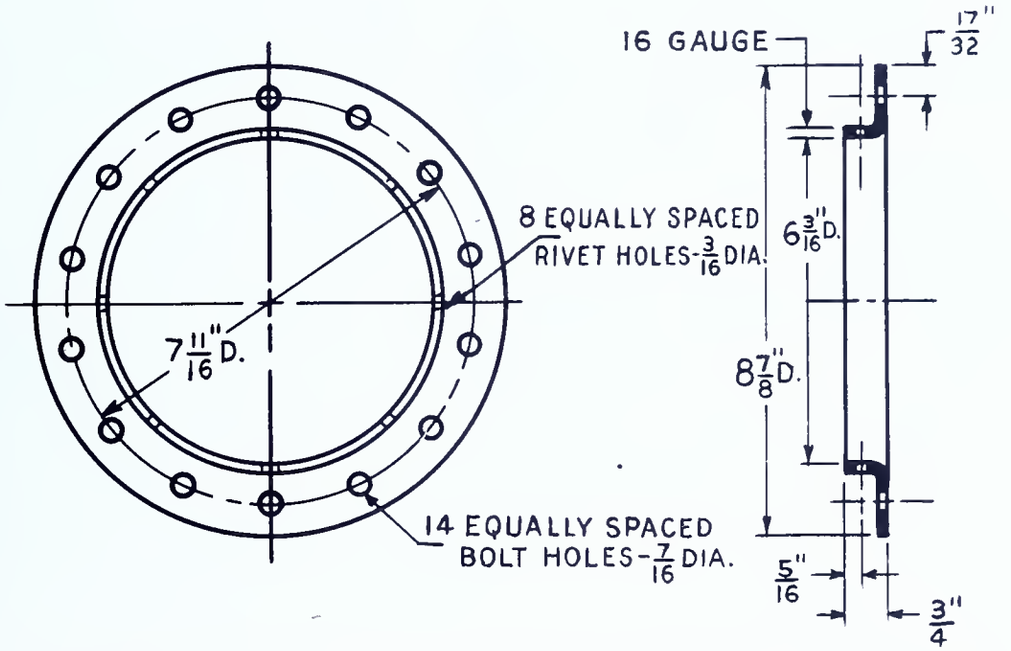
N. W. T. TO W. T. FLANGE

General Information:

A N.W.T. to W.T. flange is used to connect ducts to water-tight spools in bulk heads or decks and to water-tight closures (valves).

Specifications:

1. N.W.T. to W.T. circular flange.
2. Nominal diameter of pipe, 6 inches. Thickness .062.
3. Flange details as per specification sketch, and charts. Ref. E.
4. Metal: 16 gauge (.062) galvanized sheet steel.



SIX INCH DIA. N.W.T. TO W.T. CIRCULAR FLANGE

Tools needed:

1. Steel tape
2. Steel square, standard
3. Scriber
4. Center punch
5. Riveting hammer
6. Dividers
7. Drills
8. Open end adjustable wrench
9. Ten inch, half-round, smooth file
10. Ball peen hammer
11. Raising hammer

Equipment needed:

1. Lever shear
2. Punch press
3. Drill press
4. Nibbling machine
5. Flanging fixture, Job. 3
6. Hand punch #2

Materials needed:

1. Metal: one piece, 16 gauge (.062) galvanized sheet steel, size 12" x 12".

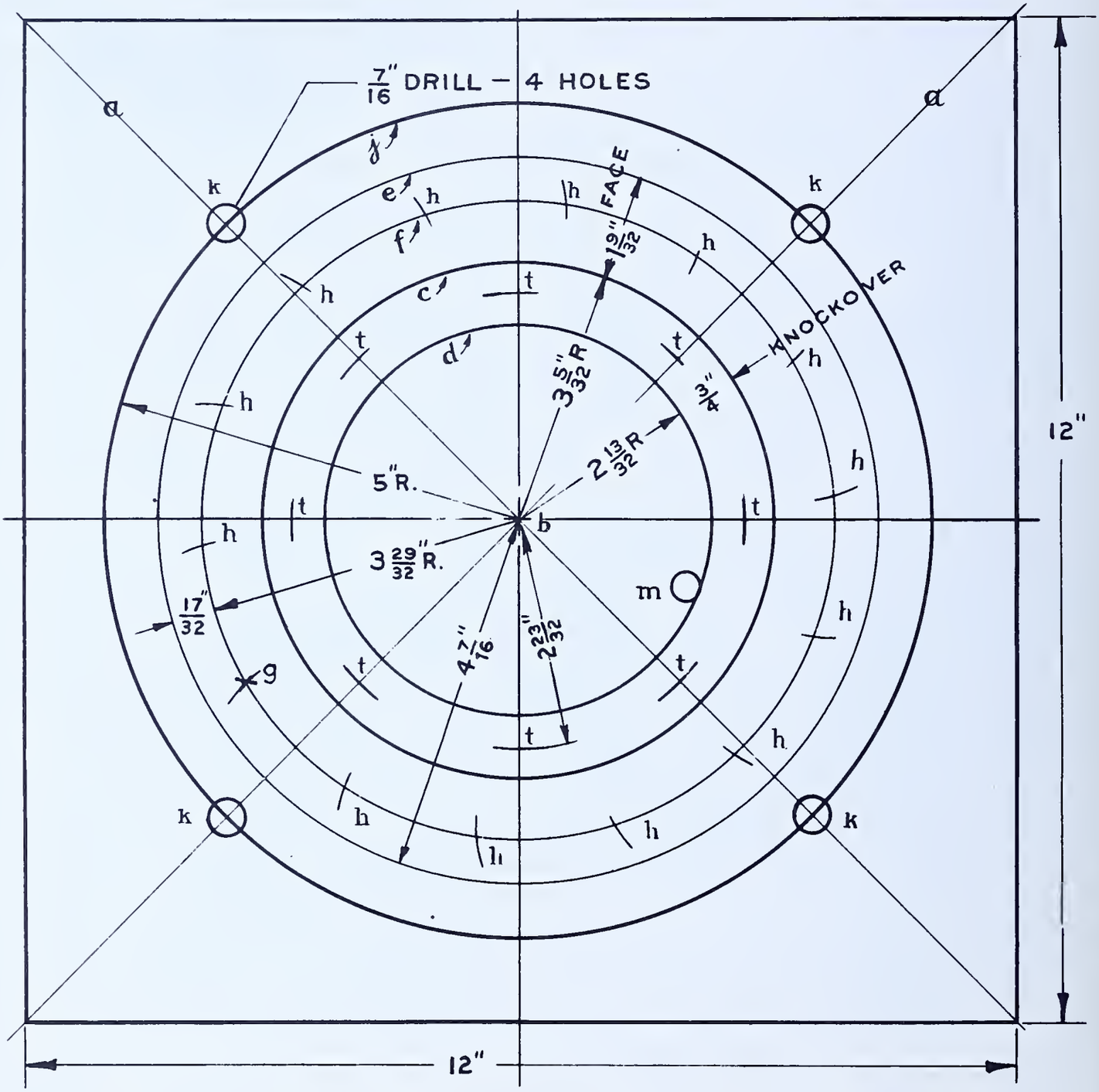


FIG. 1 — LAYOUT FOR N.W.T. TO W.T. FLANGE

Procedure:

1. Select scrap or stock metal of required gauge, from which a piece 12" x 12" can be cut.

2. Layout on metal a square 12" x 12".

3. Locate center of piece by scribing two diagonal lines "a" Fig. 1.

4. Cut piece to dimensions on lever shear.

5. Punch center, "b" Fig. 1.

*6. Set dividers equal to 3-5/32", the "knock over line" radius, and with "b" as a center scribe circumference line, "c" Fig. 1. NOTE: The radius "c" is governed by the thickness of material used in the job to be fabricated.

*7. Set dividers equal to 2-/3/32", the inside trim line radius, and with "b" as a center, scribe circumference line, "d" Fig. 1.

*8. Set dividers equal to 4-7/16", the outside trim line radius, and with "b" as a center, scribe circumference line, "e" Fig. 1.

*9. Set dividers equal to 3-29/32", the flange bolt hole radius, and with "b" as a center, scribe the circumference line, "f" Fig. 1.

*To show development, this unit works from center. In practice, the outer diameter is drawn first and standard distances measured in from there.

10. Set dividers at 2-23/32", the rivet hole radius, and scribe arcs "t" on diagonals and perpendiculars. (This will provide center marks for eight rivet holes.)

11. Center punch these intersections "t".

12. Center punch a mark "g", anywhere on the circumference line, "f" Fig. 1.

13. Divide circumference line "f" into fourteen equal spaces, marked "h", Fig. 1, using the dividers and starting from point "g". (A trial and adjustment process.)

14. Center punch each intersecting point of arcs, "h" and circumference line "f".

15. Scribe arcs to intersect the diagonal lines, "a" at four points "k" with "b" as a center and dividers set equal to 4".

16. Center punch the points, "k" Fig. 1.

17. Drill or punch 7/16" diameter holes with the points "k" as centers.

18. Drill or punch a hole with "b" Fig. 1, as a center. The diameter of this hole to be of a dimension large enough to permit the passage of the "center pin" on the circle cutting attachment of the nibbling machine.

19. Drill or punch the hole "m" tangent to the inside of the circumference line "d" Fig. 1, - the diameter of this hole to be 1/64" larger than the diameter of the "cutting tool" of the nibbling machine.

20. Place the flange blank on the circle cutting attachment of the nibbling machine so that the center pin of the slide bar passes through the center "b" of the flange blank.

21. Loosen the clamping lever of the slide bar, and slide the bar and flange blank to a position where the hole, "m" is in line with the cutting tool.

22. Pull down the hand lever, allowing cutting tool to pass through tangent hole, "m", NOTE: Lever must be pulled down far enough to allow the lift lock to become engaged with the ram spring lift.

23. Tighten the slide bar clamping lever.

24. Cut the 4-11/16" diameter hole; this is done by slowly revolving the flange blank about the center pin.

25. Release the lift lock; this will allow the removal of the flange blank which now has its center cut out.

26. File smooth the edges of the hole just cut. Do this with a 10" half-round smooth file.

27. Secure the flange fixture made in Job No. 3.

28. Unscrew the nuts and take the fixture apart.

29. Place the flange blank (with center punch marks facing up) on the part of the fixture to which the screws have been welded, allowing the screws to pass through the holes, "k".

30. Place the remaining part of the fixture in place and screw on the nuts.

31. Tighten the nuts evenly.

32. Place the fixture in the vise as shown in Fig. 2.

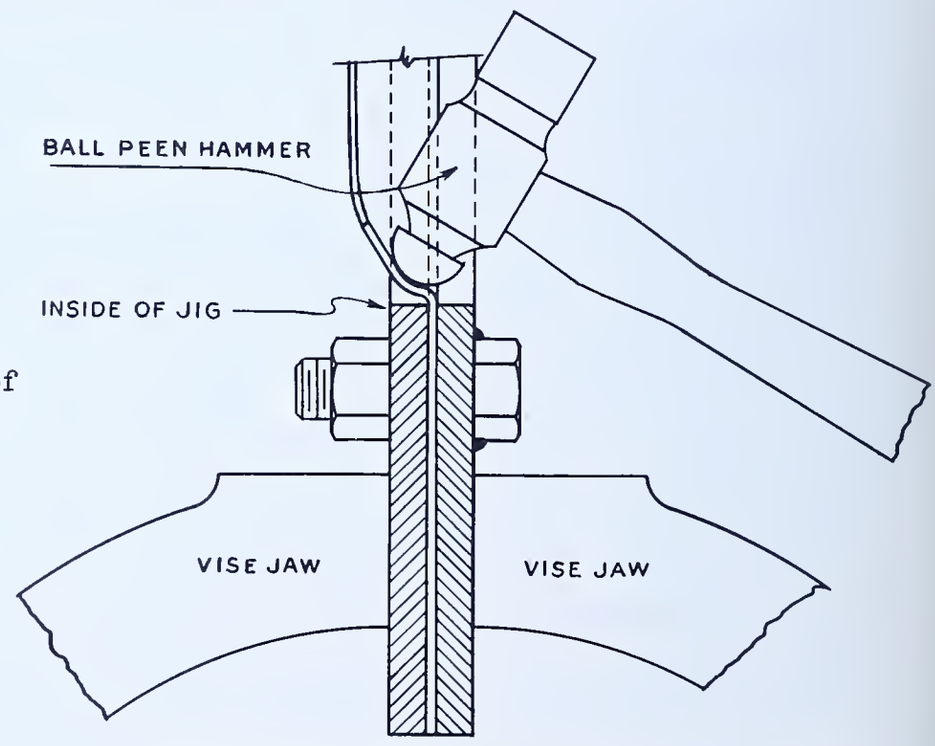


FIG. 2 — FLANGING FIXTURE HELD IN VISE

30. Place the remaining part of the fixture in place and screw on the nuts.

31. Tighten the nuts evenly.

32. Place the fixture in the vise as shown in Fig. 2.

33. Hammer part of the flange over, striking the metal with the ball part of the ball peen hammer, Fig. 2.
    NOTE: Hammer flange over toward that side of fixture which has tightening nuts on. This will keep the scribed circumference line "e" in a position that can be seen when the outer part of the flange blank is trimmed off. The first blows are delivered as close as possible to the flange bending line. This is done for the total distance around the flange. The position of the fixture in the vise should be changed from time to time so that when a blow is struck, that part of the flange receiving the blow will be between the jaws of the vise.

34. Continue hammering as in Procedure 33 until the flange has been knocked over 90 degrees.

35. Remove flange from fixture. Reassemble fixture and return it to its storage place.

36. Cut off material outside of circumference line "e"; do this with the lever shear.

37. Punch 14 holes, 7/16" diameter, through the centers "h" Fig. 1.

38. Punch 3/16" diameter holes for rivets through centers "y".

39. Deburr holes and edges using a 10" half-round, smooth file. Flange is then completed.

References:

1. Reference E — "Description of Flanges".

Questions:

1. What determines the size of the flange blank?
2. What is the difference between a N.W.T. to W.T. llange, and a N.W.T. intermediate flange?
3. What is the diameter of the rivet holes in the flange?
4. What is the diameter of the bolt holes in the flange?
5. Why does the instruction specify which side of the flange is to be hammered over?

HOW TO FABRICATE A FLANGE GASKET AND GROMMETS

Objective:

1. To learn how to fabricate a flange gasket and grommets.

General Information:

Where two flanges are connected, a 1/8" fabric-reinforced rubber gasket is placed between the flanges so that the joint will be fume-tight (or water-tight if required). Gaskets are cut from specified sheet stock. They are made larger than the opening so that they will not project into the pipe when tightened into place.

Where specified, canvas also may be used in making gaskets. The canvas gasket is made from two or more thicknesses of heavy canvas saturated with white lead or other specified compound. Grommets are used with canvas gaskets; they may not be required when rubber gaskets are used.

Specifications:

Dimensions: Inside diam. 6-1/8"
Outside diam. 8-3/4"
Bolt circle, 7-11/16"
Material: 1/8" fabric-reinforced rubber to fit 6" diam.
N.W.T. to W.T. flange.

Tools needed:

1. Scriber
2. Hollow punch 7/16"
3. Rule
4. Mallet
5. Straight snips
6. Circular snips
7. Dividers

Equipment needed:

1. Template of flange

Materials:

1/8" Rubber gasket material

Procedure:

1. Procure flange template.
   Since flanges are standard sizes, a template will fit any flange of a given size and specification. If a template is not available, a flange may be used for laying out the gasket.
2. Cut a piece of gasket material sufficiently large for gasket. (Use scrap if possible.)
3. Lay template or flange on gasket material.
4. Mark inside and outside of flange bolt hole locations with scriber.

5. Punch bolt holes in gasket, using required size of hollow punch. To punch holes, place a lead or wooden block under a hole location, position punch, and strike with mallet.
6. Trim the outside circumference, using straight shears.
7. Fold gasket in the center with marked face showing, and snip for start of inside circumference. Fig. 1.
8. Unfold gasket and place on bench.
9. Cut out inside circumference, using hand shears. DO NOT DAMAGE SCRAP PIECE (the inside circle). It often is possible to cut a smaller gasket from this scrap piece.
10. Tie completed gasket to flange, so that it will be available for assembly.

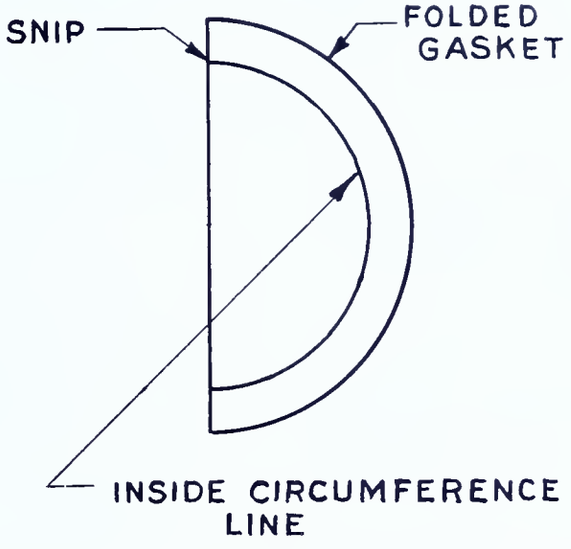


FIG. 1— START OF INSIDE CUT

HOW TO MAKE GROMMETS AND INSTALL GROMMETS AND FLANGE BOLTS

General Information:

Grommets are used to prevent leakage of a gasket in way of bolts and flange holes.

Grommets are made from cotton wicking or other specified material.

Procedure:

1. Cut a piece of 1/8" round wicking about 6" long. This is approximately the length required to make a grommet for a 3/8" bolt.

2. Wind wicking around a drift pin, at a point on the pin slightly larger than required bolt diameter. Fig. 1.

3. Using a rolling motion, strip the grommet from the drift pin so that the various windings intertwine to form one closely compacted mass, in the shape of a washer. Fig. 2.

4. Dip the grommet in a specified composition (usually zinc chromate). This paint assists in holding the strands of the grommet together.

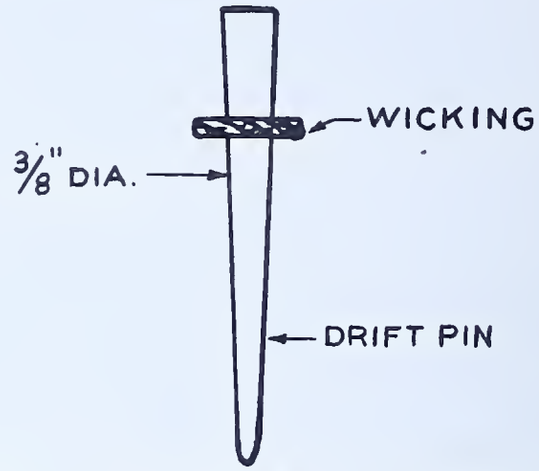


FIG. 1 — GROMMET ON DRIFT PIN

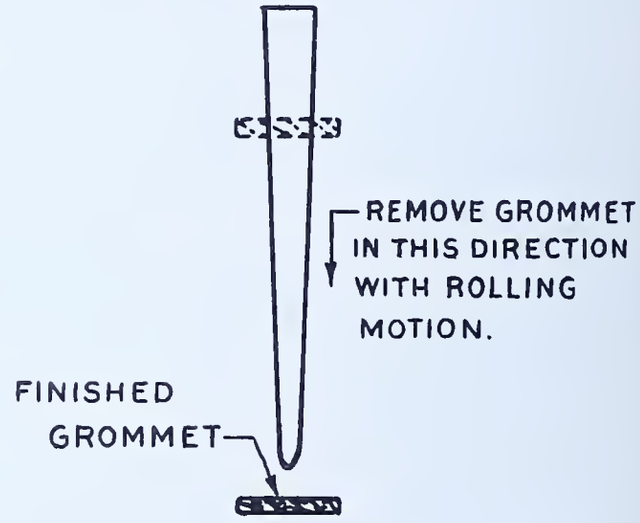


FIG. 2 — STRIPPING GROMMET

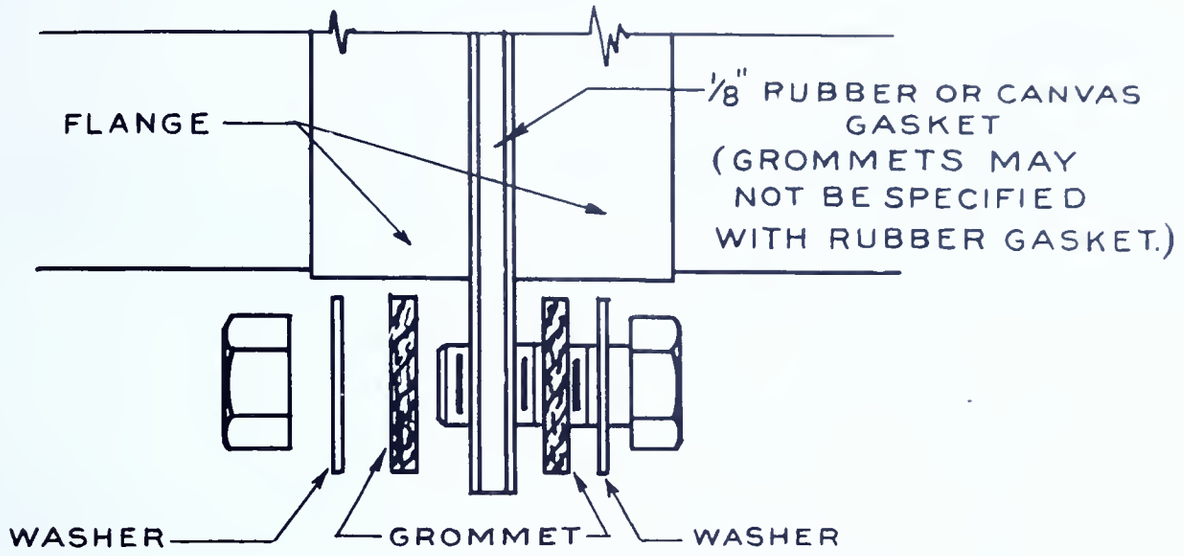


FIG. 3 — GROMMETS PLACED ON BOLT

5. Assemble a steel washer on required bolt. Fig. 3

6. Place dipped grommet on bolt next to washer

7. Insert bolt in flange holes.

8. Place second dipped grommet on protruding threaded end of bolt.

9. Place steel washer, over grommet then nut, and draw up with fingers.

10. Insert other flange bolts, grommets, washers, and nuts, and draw up "finger tight".

11. Uniformly tighten all nuts, proceeding progressively from one to another, so as to secure uniform tension.

FABRICATE AN INTERMEDIATE N.W.T. CIRCULAR FLANGE

Objective:

1. To learn how to make an intermediate N.W.T. flange.

General Information:

An intermediate line is a fume-tight, but not water-tight line made of lighter gauge metal between two water-tight fittings. It is used to reduce weight.

An intermediate flange is one inserted in that line about every eight feet to provide opportunity for maintenance removal of N.W.T. pipe and easier handling while installing.

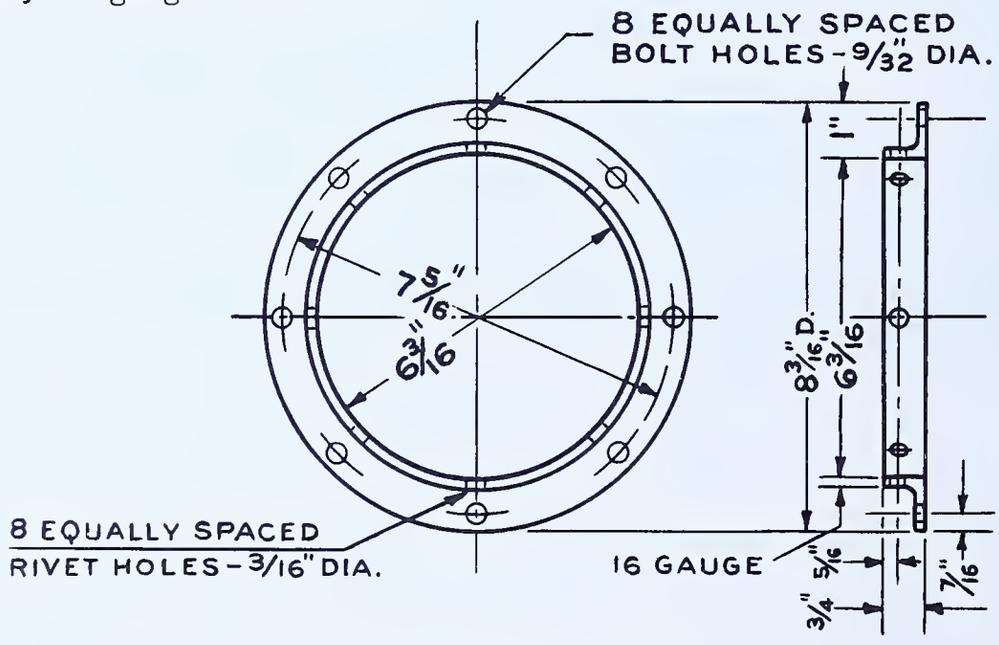
Since flanges of a given size and style are interchangeable, it is necessary that exact specifications or patterns be used in fabricating all types of flanges.

Where a quantity of circular flanges must be made the flanges sometimes are spun on engine lathes. However, the general procedure in making flanges is to form the flange by hand with the aid of a flanging fixture.

INTERMEDIATE N. W. T. CIRCULAR FLANGE

Specifications:

1. N.W.T. Circular Flange.
2. Nominal diameter of pipe, 6" thickness .062.
2. Flange details as per specification sketch. (Fig. 1)
4. Metal, 16 gauge sheet steel.



JOB 6 INTERMEDIATE N.W.T. CIRCULAR FLANGE

Tools needed:

1. Tape rule
2. Two foot square
3. Scriber
4. Center punch
5. Riveting hammer
6. Dividers
7. Hand punch (No. 2)
8. Drills
9. Open end adjustable Wrench
10. Ten inch half-round smooth file
11. Ball peen hammer
12. Raising hammer

Equipment needed:

1. Lever shear
2. Punch press
3. Drill press
4. Nibbling machine
5. Flanging fixture

Material needed:

1. One piece, 16 gauge (.062) galvanized sheet metal, size 8-1/2" x 8-1/2".

Procedure:

1. Select scrap or stock metal of required gauge, from which a piece approximately 8-1/2" x 8-1/2" can be cut.
2. Lay out on metal a square $8\frac{1}{2}$" x $8\frac{1}{2}$".
3. Cut piece to dimensions on square shear.
4. Locate center of piece by scribing diagonal lines, "a" Fig. 1.
5. Punch center, "b".
6. Set dividers to 2-7/16", the inside trim line radius, and with "b" as a center, scribe circumference line "c".
7. Set dividers to 3-5/32", the bend line radius, and with "b" as a center, scribe bend line, "d".
8. Set dividers to 4-3/32", the outside trim line radius, and with "b" as a center, scribe circumference line "e".

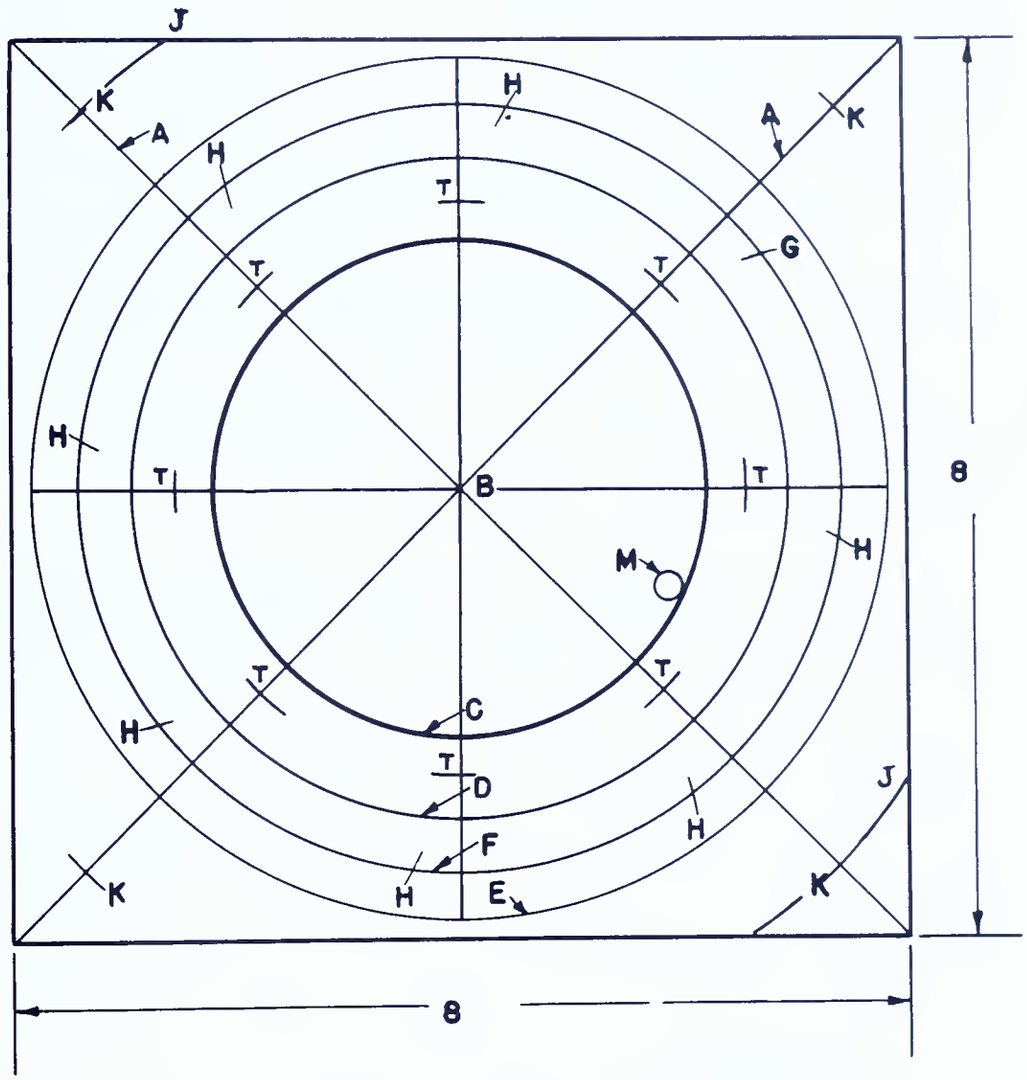


FIG. 1 — LAYOUT FOR A FLANGE

9. Set dividers to 3-21/32", the flange bolt hole radius, and with "b" as a center, scribe circumference line "f".

10. Set dividers at 2-3/4", the rivet hole radius, and scribe arcs "t" on diagonals and perpendiculars. (This will provide center marks for eight rivet holes).

11. Center punch these intersections "t".

12. Center punch a mark "g", anywhere on the circumference line "f".

13. Divide circumference line "f" into eight equal spaces marked "h", - using the dividers and starting from point "g".

14. Center punch each intersection point of arcs, "h", on circumference line "f".

15. Scribe a circumference line "j", with "b" as a center and dividers set to 5", to intersect the diagonal lines "a" at four points "k".

16. Center punch the points "k".

17. Drill or punch 7/16" diameter holes with the points "k" as centers.

18. Drill or punch a hole with "b" as a center, - the diameter of this hole to be of a dimension large enough to permit the passage of the "center pin" on the circle cutting attachment of the nibbling machine.

19. Drill or punch the hole "m" tangent to the inside of the circumference line, "c" Fig. 1, - the diameter of this hole should be made 1/64" larger than the diameter of the "cutting tool" of the nibbling machine.

20. Place the flange blank on the circle cutting attachment of the nibbling machine so that the center pin of the slide bar passes through the center "b" of the flange blank.

21. Loosen the clamping lever of the slide bar and slide the bar and flange blank to a position where the tangent hole "m" is in line with the cutting tool.

22. Pull down the hand lever, allowing cutting tool to pass through tangent hole "m".

    Note: Lever must be pulled down far enough to allow the lift lock to become engaged with the ram spring lift.

23. Tighten the slide bar by turning the clamping lever.

24. Cut out the 4-7/8" dia. hole; this is done by slowly revolving the flange blank about the center pin.

25. Release the lift lock; this will allow the removal of the flange blank which now has its center cut out.

26. File smooth the edges of the hole just cut with a 10" half-round smooth file.

27. Secure the flange fixture made in Job 3.

28. Unscrew the nuts and take the fixture apart.

29. Place the flange blank (with center punch marks facing up) on the part of the fixture to which the screws have been welded, - allowing the screws to pass through the holes, "k".

30. Place the remaining part of the fixture in place and screw on the nuts.

31. Tighten the nuts evenly.

32. Place the fixture in the vise and proceed to knock over the flange as outlined in the Procedure of Job 4.

    Note: Knock flange over toward that side of fixture which has tightening nuts on. This will keep the scribed circumference line "e" in a position that can be seen when the outer part of the flange blank is trimmed off.

33. Remove flange from fixture, reassemble fixture and return to its storage place.

34. Cut off material outside of circumference line "e"; do this on the lever shear.

35. Punch eight holes, 9/32" diameter through the centers "h".

36. Punch 3/16" diameter holes through center punch marks "t" for rivets.

37. Deburr holes and edges with a 10" half-round smooth file.

    Flange is then completed.

References:

1. Reference "E" - Description of Flanges.
2. Job No. 3 - "How to Fabricate a Fixture for a Circular Flange".
3. Job No. 4 - "How to Fabricate a N.W.T. to W.T. Flange".

Questions:

1. What determines the size of the "flange blank"?
2. Why was it desired to have the scribed circumference line "e" on one particular side?
3. List the parts of the flange made in this lesson that are different from the flange made in Lesson 3.

FABRICATE A FIXTURE FOR N.W.T. RECTANGULAR FLANGE

Objectives:

1. To learn how to make a fixture for N.W.T. rectangular flange.
2. To learn how to spot or tack weld a flange.

General Information:

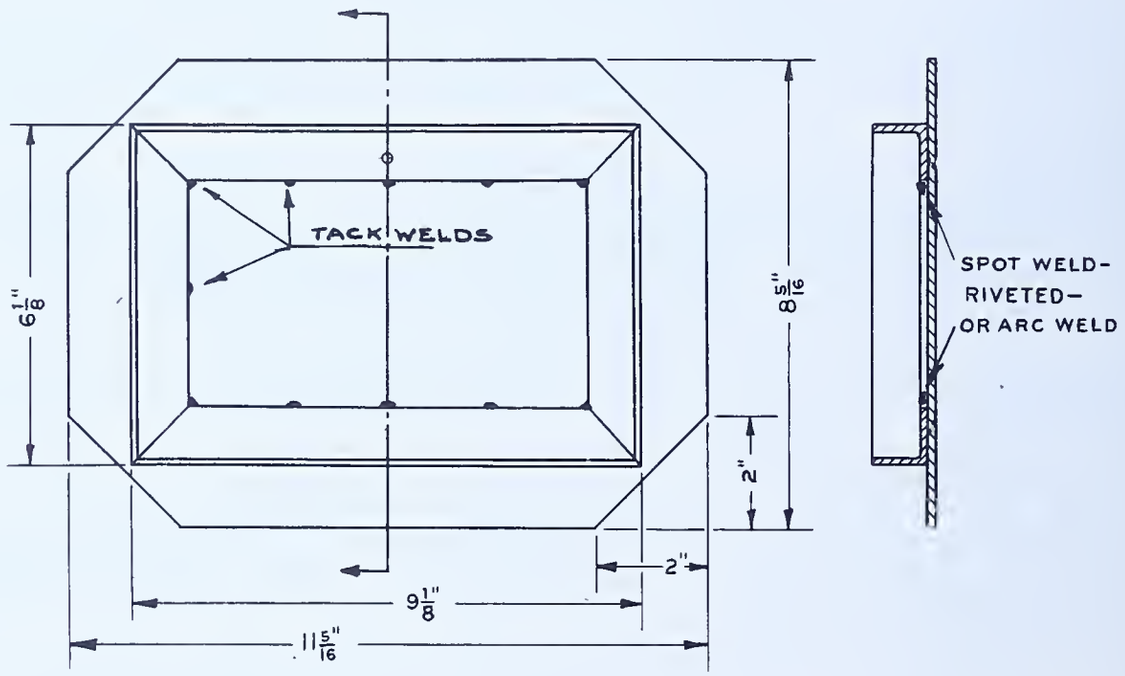
When several rectangular flanges of the same dimension are to be made, a fixture or jig is fabricated for production purposes to maintain uniform companion flanges.

It is important that fixtures be constructed accurately and strong to withstand shop wear. Each fixture should be clearly identified by name and size. Small bolt holes are usually punched in plate to act as "pilot" holes for flange bolt holes.

FIXTURE FOR RECTANGULAR FLANGE

Specifications:

1. Dimensions: 8-5/16" x 11-5/16" x 1/8 (.125) M. S.
2. Metal: 14 gauge (.078) galvanized sheet steel 1" x 1" x 1/8 angle.
3. Seams: butt welded.
4. Arc weld angles to place.



JOB 7 — WELDING FIXTURE FOR 6"X9" RECT. N.W.T. FLANGE

Tools needed:

1. Combination square
2. Scriber
3. File
4. Hack saw
5. Framing square

Equipment needed:

1. Squaring shears
2. Arc welding equipment

Materials Needed:

1. Metal - One piece 8-5/16" x 11-5/16" x 1/8 (.125)
   Two pieces 1" x 1" x 1/8 angle
   Two pieces 1" x 1" x 1/8 angle

Procedure:

1. Read drawing and specifications.
2. Select material from scrap or stock.
3. Lay out a rectangle on the base plate the size of flange.
4. Measure diagonal and check for accuracy.
5. Trim corners of plate as shown in sketch.
6. Lay out and scribe miters on all pieces. See sketch.
7. Cut mitres on angles to lengths required.
8. Check angles for size, miter, and length.
9. Clamp angles to base plate on lines of rectangle.
10. Check for alignment.
11. Arc weld angles to plate.
12. Check fixture for accuracy after welding.
13. Dress corners and mark fixture, "6-1/8" x 9-1/8" Rectangular Flange Fixture".

References:

1. Reference K - Electric Spot Welding
2. Reference L - How to Make a Spot Weld
3. Reference M - How to Make a Test Weld
4. Reference E - Description of Flanges
5. Job Sheet No. 4 - How to Make a Flange

Questions:

1. Why are the corners removed on the base of a fixture?
2. If arc welding equipment is not available, what other methods can be used to secure angles to the base of fixture?

HOW TO MAKE A N.W.T. RECTANGULAR FLANGE

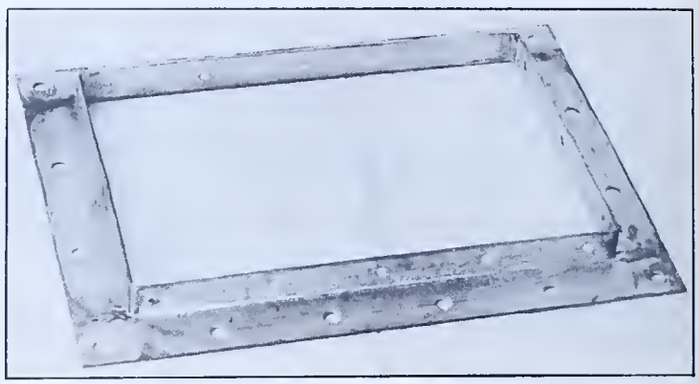
Objectives:

1. To learn how to make a N.W.T. rectangular flange.
2. To learn how to weld flanges.

General Information:

Square or rectangular flanges are made by laying out, cutting, and forming the angles and then welding the four angles together by securing them to a special fixture with "C" clamps. Care should be practiced in every procedure required to make the flange. A tolerance of 1/16" may be permitted above the given dimension.

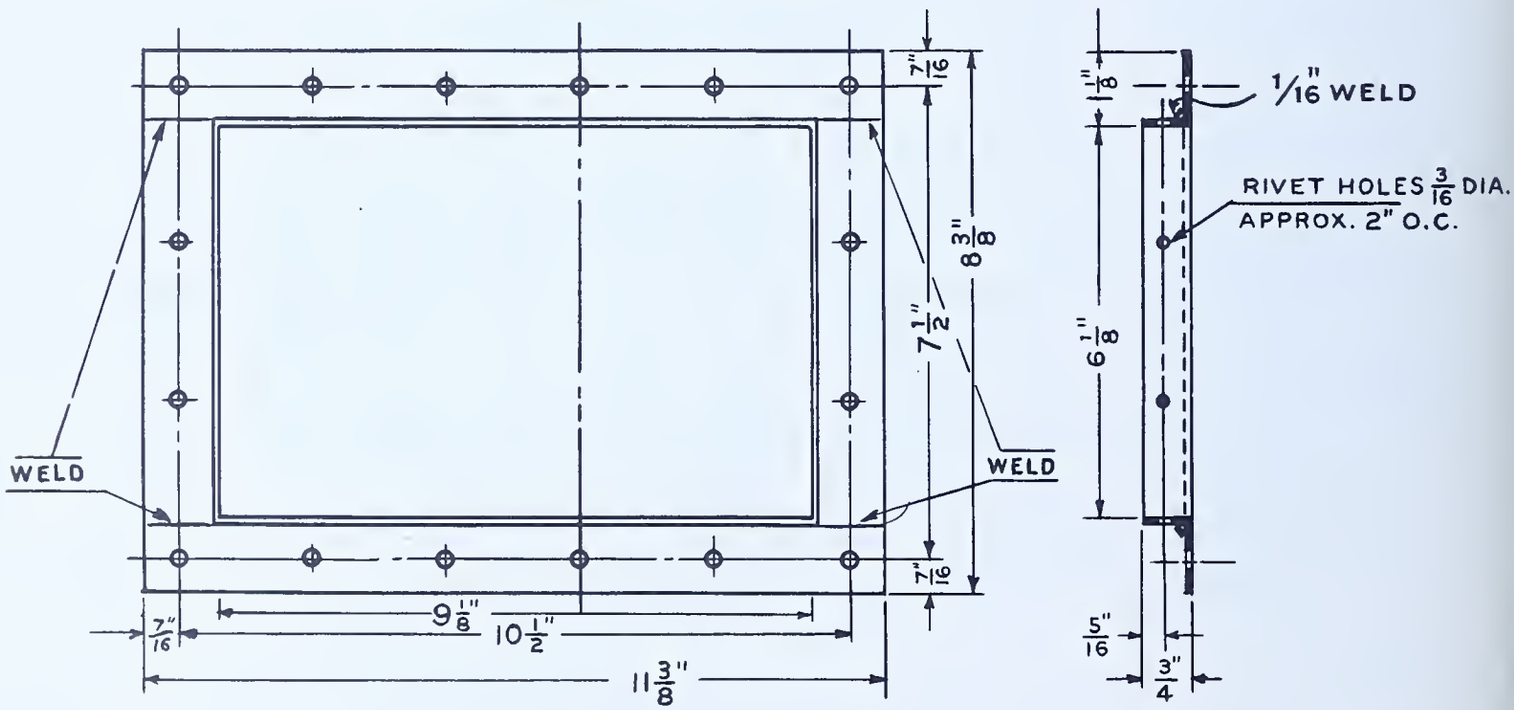
This type of flange simplifies the assembly procedure and makes it possible to remove a section for repair or alteration.



N. W. T. RECTANGULAR FLANGE

Specifications:

1. Dimensions: 8-A: 6-1/8" x 9-1/8" as illustrated.
   8-B: 5-1/8" x 8-1/8"
2. Metal: 14 gauge (.078) galvanized sheet steel.
3. Seams: butt welded.
4. Rivets: spaced approximately 2" C. to C.



JOB-8 — RECTANGULAR N.W.T. FLANGE — 6" X 9"

Tools needed:

1. Hammer
2. Center punch
3. Dividers
4. Combination square
5. Scribers
6. File
7. Rule

Equipment needed:

1. "C" clamps
2. Squaring shears
3. Brake
4. Hand punch
5. Welding service
6. Flange fixture
7. Grinder and goggles
8. Paint

Materials needed:

1. Metal: Two pieces 1-3/4" x 11-5/16".
Two pieces 1-3/4" x 6-1/16".

Procedures:

1. Study prints and specifications of job.
2. Select scrap or stock metal of required gauge.
3. Lay out parts as shown in sketches. It is customary in shop practice to lay out the holes with standard pattern or template after the angles have been welded.
4. Cut notches on lever shear.
5. Form angles for flange, Fig. 1.
6. Check angles for accuracy and mount flange parts to fixture with "C" clamps. If a fixture is not available, construct one as outlined in Job. Sheet 7.
7. Weld flanges and smooth the welded surfaces.

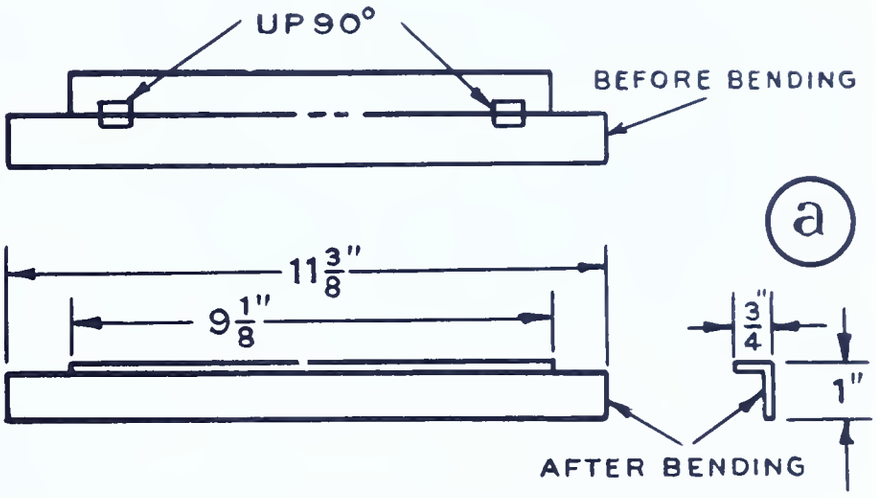


FIG. 1 — LONG ANGLE LAYOUT

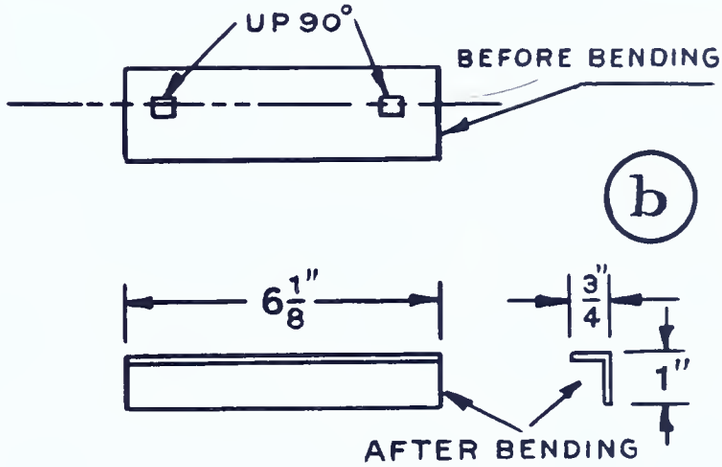


FIG. 2 — SHORT ANGLE LAYOUT

8. Secure template with arrangement of holes on companion flange, center or align for holes, and center punch holes.

9. Check holes for accuracy with a pair of dividers, and drill 9/32" holes for face of flange.

10. Locate holes on flange adjoining ventilation pipe and drill 3/16" holes for pipe landing.

11. Deburr holes and corners.

12. Paint surfaces to prevent oxidization.

References:

1. Reference K - Electric Spot Welding.
2. Reference L - How to Make a Spot Weld.
3. Reference M - How to Make a Test Weld.
4. Reference E - Description of Flanges.
5. Job 7 - Fabricate a Fixture for a N.W.T. Rectangular Flange.

Questions:

1. Why do you use the template for locating holes after welding flanges?
2. What size bolts would you use for companion holes?
3. What size rivets would you use for riveting flange to duct?

4. What should a workman do before using the template?
5. Why are the corners notched on the fixture?

FABRICATE A SPOOL

Objective:

1. To learn how to fabricate a spool.

General Information:

A spool is a fitting that is used where a duct passes through a bulkhead, deck or deck beam. It consists of a cylindrical body of a specified thickness to which two W.T. flanges are welded. The spool, being welded to the member through which it passes, compensates in part for any weakness that would be caused by cutting a hole in a structural member such as a deck beam. For best results they are circular or flat oval in shape and are fabricated of a heavier gauge metal than the duct. The specified metal for the spool is a mild steel (M.S.) of a thickness between .125 and .250 of an inch depending upon the thickness of the structure intersected by the spool.

SPOOLS — ROUND AND FLAT OVAL

Runs of rectangular ducts that pass through important structural members are usually transformed to flat oval shpe at the point of passage and then back to rectangular shape on the other side. Occasionally a rectangular spool is used. When this form of spool is used, care is taken to have a radius in all four corners of the cut-out. All spool diameters are measured on the inside. W.T. flanges are welded to each end of the spool to provide a means of attaching the duct.

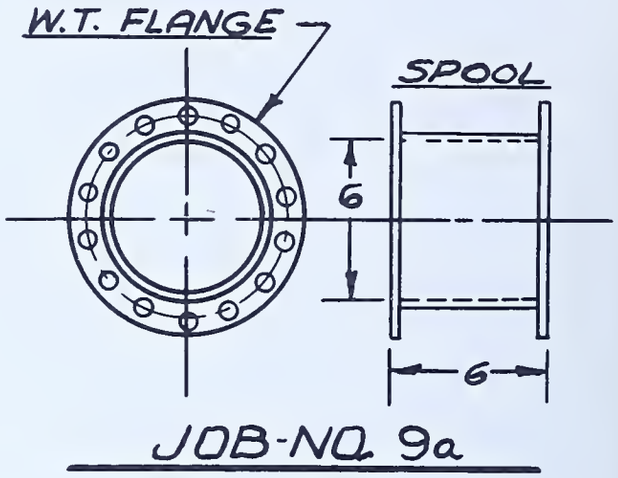
Unless otherwise specified, spools and W.T. flanges are made of black

iron, welded and then hot-dipped galvanized. If galvanized stock is used, the galvanizing would flake off due to the stretching and shrinking when the cylinder is rolled to shape.

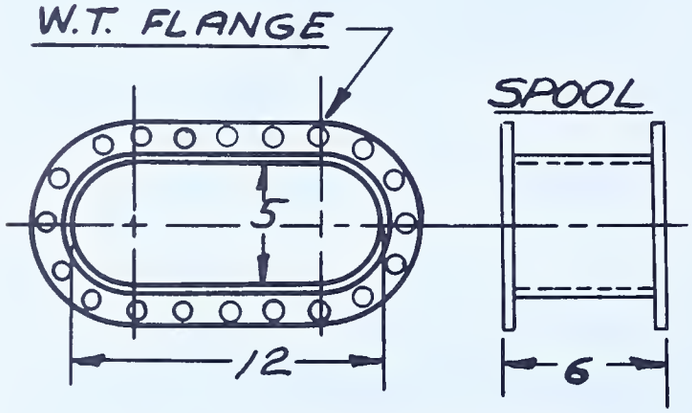
This job consists of three different size spools. Make only the one specified by the instructor.

Specifications:

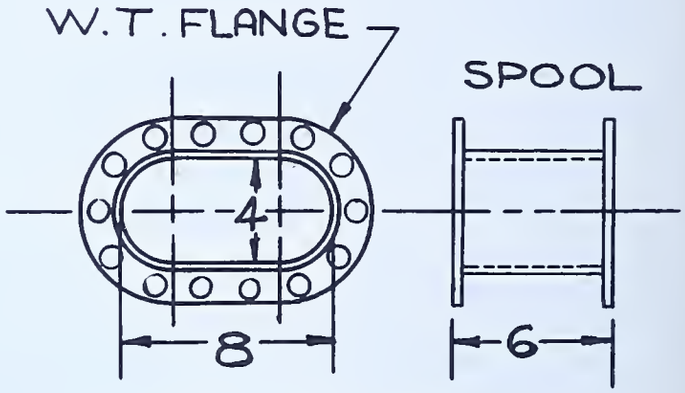
1. Job No. 9a Fig. 1.
   a) Dimensions: Diameter, 6 inches;
      Length, 6 inches.
   b) Metal thickness: Spool, .125 M.S.
      Flange, .187 M.S.
2. Job No. 9b Fig. 2.
   a) Dimensions: Flat oval, 5" x 12";
      Length, 6 inches.
   b) Metal thickness: Spool, .125 M.S.;
      Flange, .187 M.S.
3. Job No. 9c Fig. 3
   a) Dimensions: Flat oval, 4" x 8";
      Length, 6 inches.
   b) Metal thickness: Spool, .125 M.S.;
      Flange, .187 M.S.



JOB-NO. 9a



JOB NO. 9b



JOB. NO. 9c

Tools needed:

1. Metal gauge
2. Tape rule
3. Center punch
4. Riveting hammer
5. 10 inch, half-round file
6. Drills

Equipment needed:

1. Square shear
2. Lever shear
3. Band saw
4. Nibbling machine
5. Heavy duty slip roll
6. Portable grinder
7. Punch press or drill press

Materials needed:

1. Job No. 9a
   a) Spool: One piece .125 black (M.S. uncoated) sheet steel 6" x 19-1/4".
   b) Flanges: Two pieces .187 black sheet steel 9" x 9".
2. Job No. 9b
   a) Spool Two pieces .125 black sheet steel 6" x 15-1/16".
   b) Flanges: Two pieces .187 black sheet steel 8" x 15".
3. Job No. 9c
   a) Spool Two pieces .125 black sheet steel 6" x 10-15/32".
   b) Flanges: Two pieces .187 black sheet steel 7" x 11".

Procedure:

1. Secure patterns and shape template (or develop patterns and shape template as directed). Refer to Fig. 4 sheet 6 of this job.
2. Study specifications of job.
3. Select scrap or stock metal of required thickness.
4. Transfer patterns to metal.
5. Cut spool blank to specified size on the square shear.
   Note: If the capacity of the shop's shears is not sufficient for shearing the thickness used to make the spool, the blank may be cut to size using the band saw or burning outfit.
6. Cut flange out on the nibbling machine. See Reference N.
7. File the outside edge of the flange smooth.
8. Grind seam edges of spool for welding. (Fig. 1)

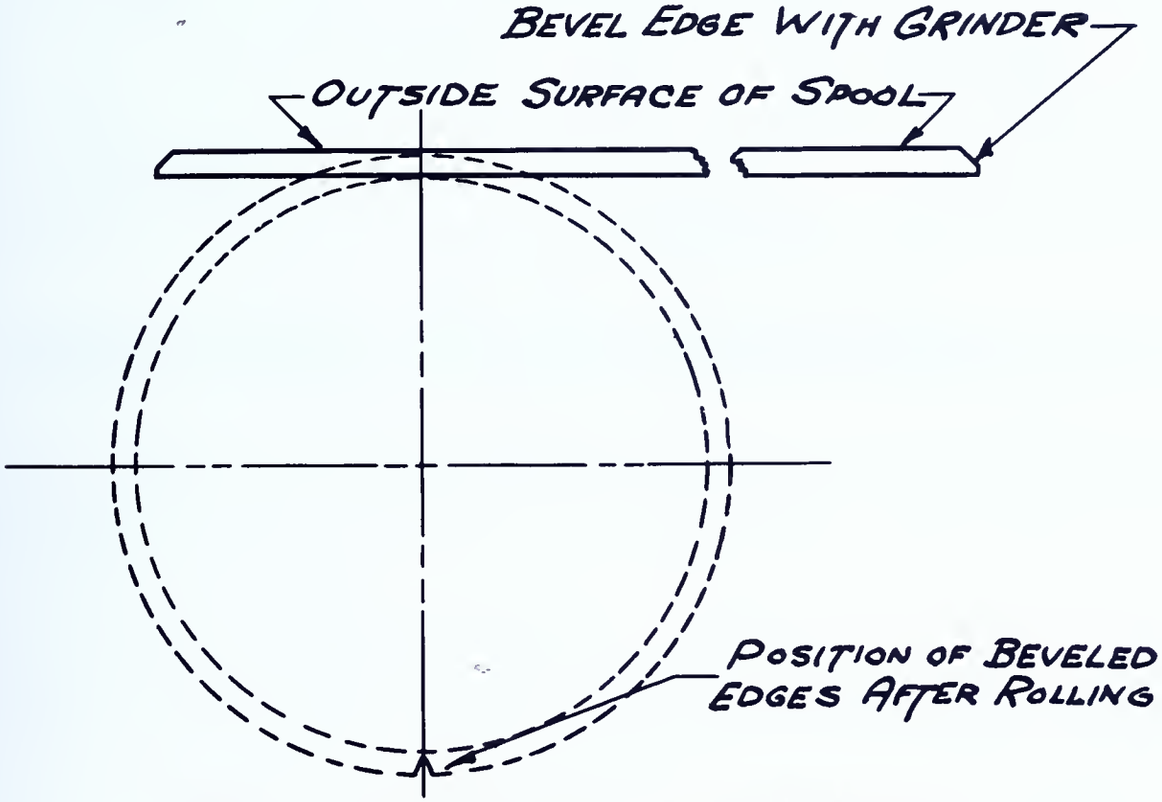


FIG. 1 - SEAM EDGES PREPARED FOR WELDING

9. Roll spools to shape on the roller.
10. Punch or drill flange bolt holes.
11. Deliver spool and one flange to welding shop with pencil sketch, Fig. 2, showing desired welding.

Note: Some ship yard procedures call for tacking (arc or gas welding a small area about the size of a dime) the loose (second) flange in place. This second flange is then knocked loose from the spool at time of installation. See Fig. 3. Others temporarily fasten the loose flange to the welded flange by means of a wire passed through the bolt holes.

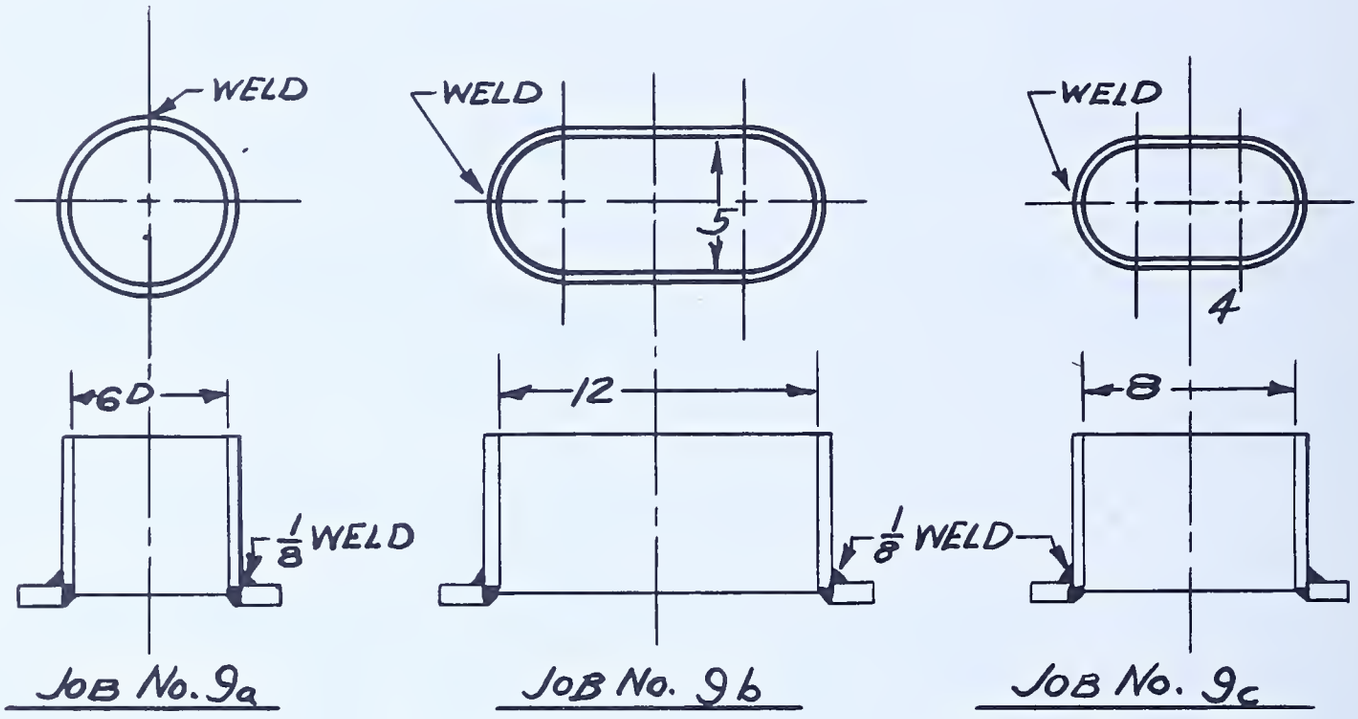


FIG. 2 - SECTIONS SHOWING WELDING DETAIL

12. Clean welds with a wire brush and a portable grinder.
13. Attach the loose flange to the welded flange with wire. Spool is now ready for galvanizing, after which it can be installed in its proper place.

References:

1. Reference C - How to Lay-out a Welded Pipe (Stretchout Dimensions)
2. Reference E - Description of Flanges
3. Reference N - How to Use the Nibbling Machine

Questions:

1. How were the "stretchout" measurements calculated for each spool made in this job?
2. Why is only one flange completely welded to the spool in the welding shop?
3. Why is it necessary to use a spool where a duct passes through a deck beam?
4. Why are spools fabricated from black iron?
5. What is meant by the capacity of a machine?

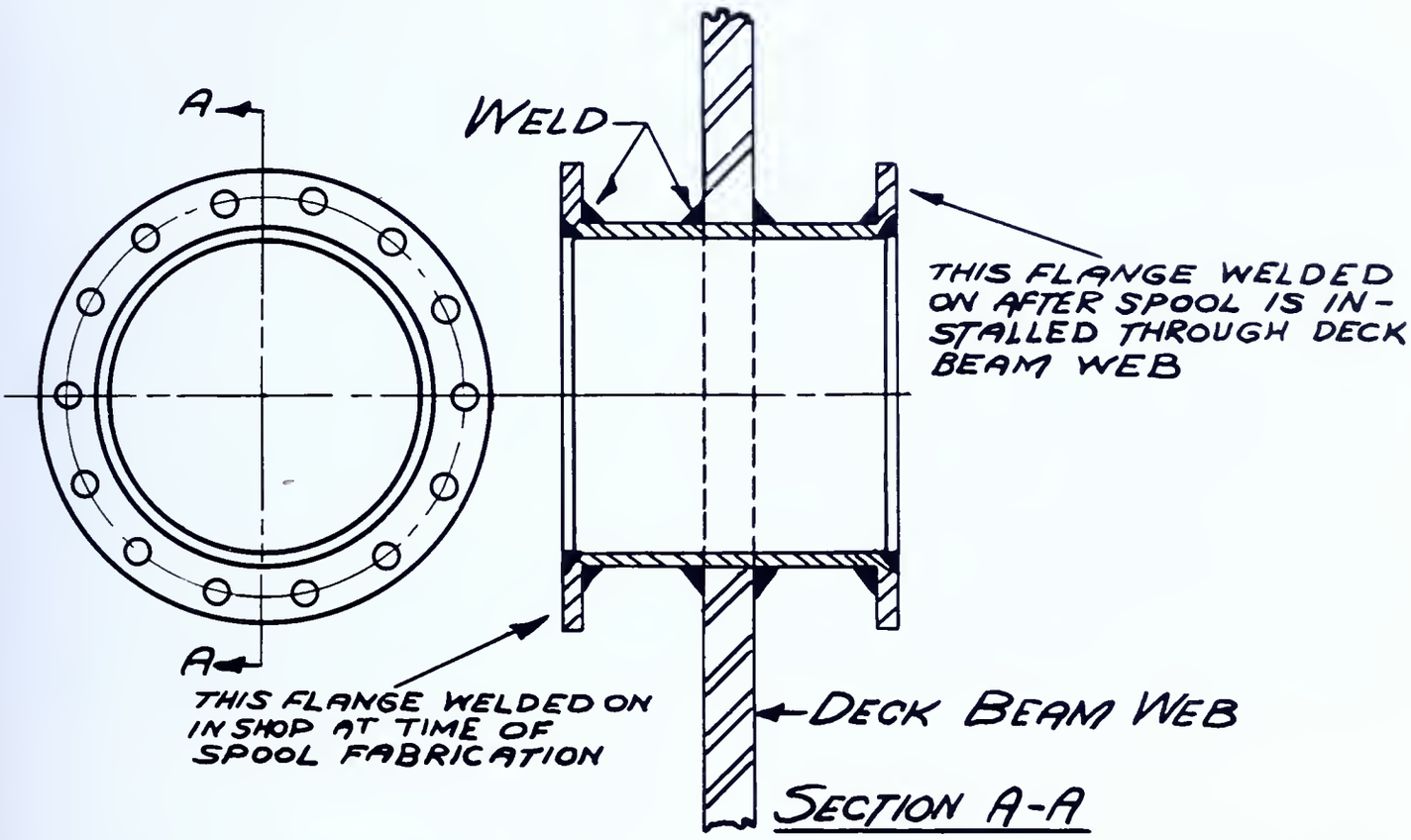
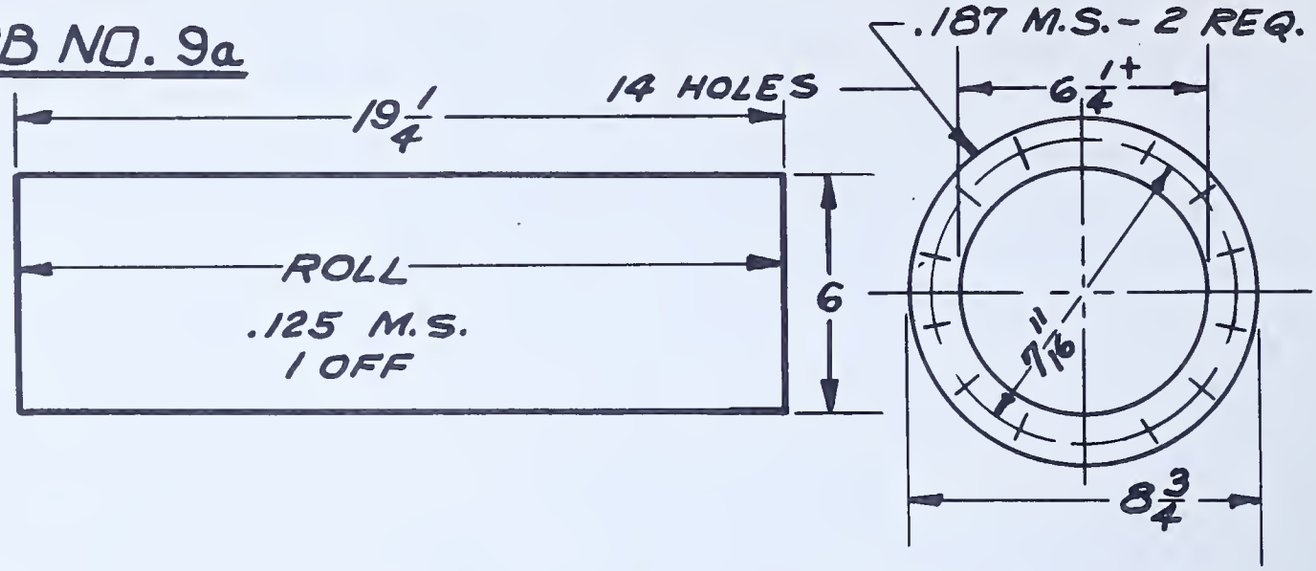
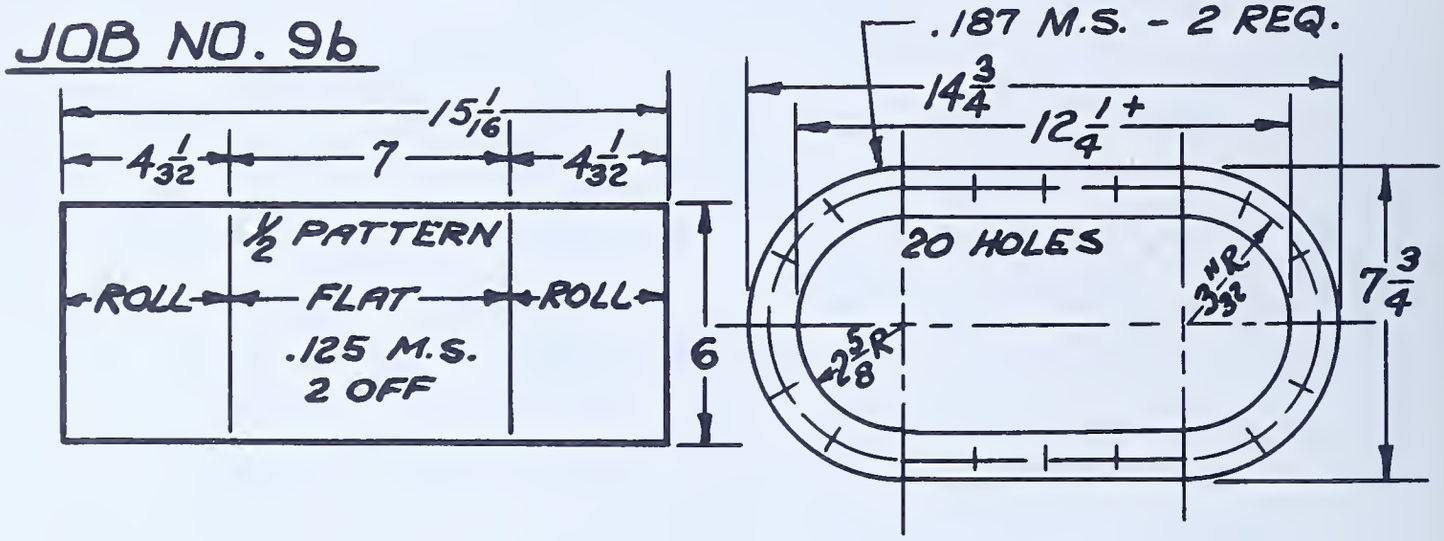

A
WELD
THIS FLANGE WELDED ON AFTER SPOOL IS IN-STALLED THROUGH DECK BEAM WEB
A
THIS FLANGE WELDED ON IN SHOP AT TIME OF SPOOL FABRICATION
DECK BEAM WEB
SECTION A-A

FIG. 3 - SPOOL INSTALLATION

JOB NO. 9a



JOB NO. 9b



JOB NO. 9c

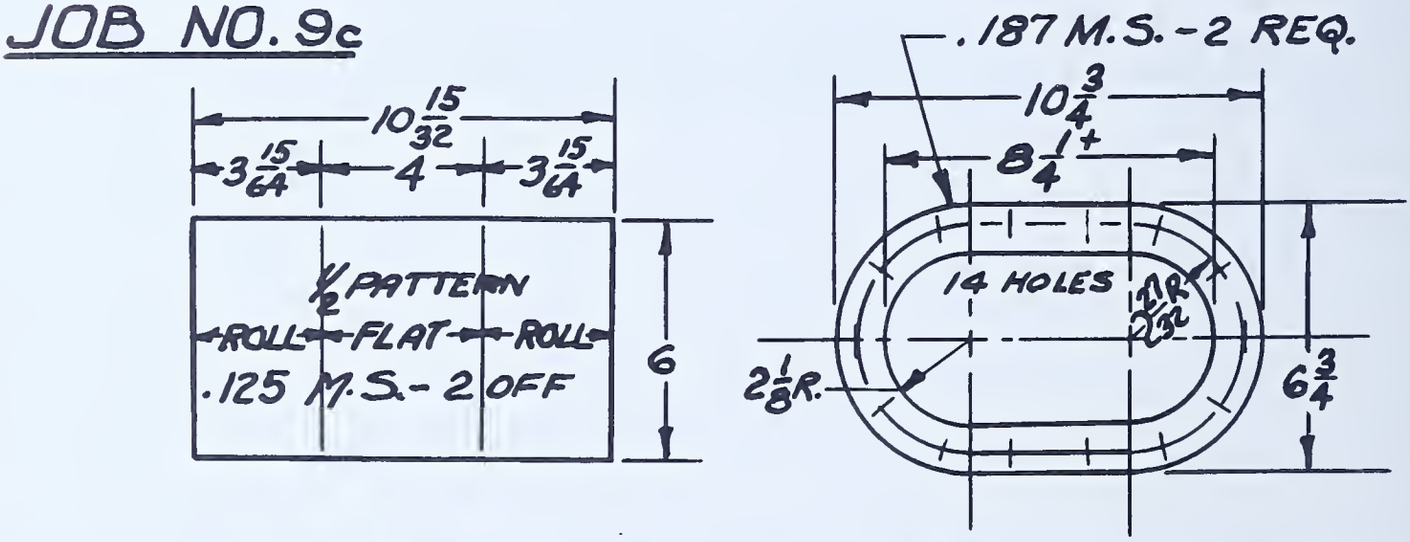
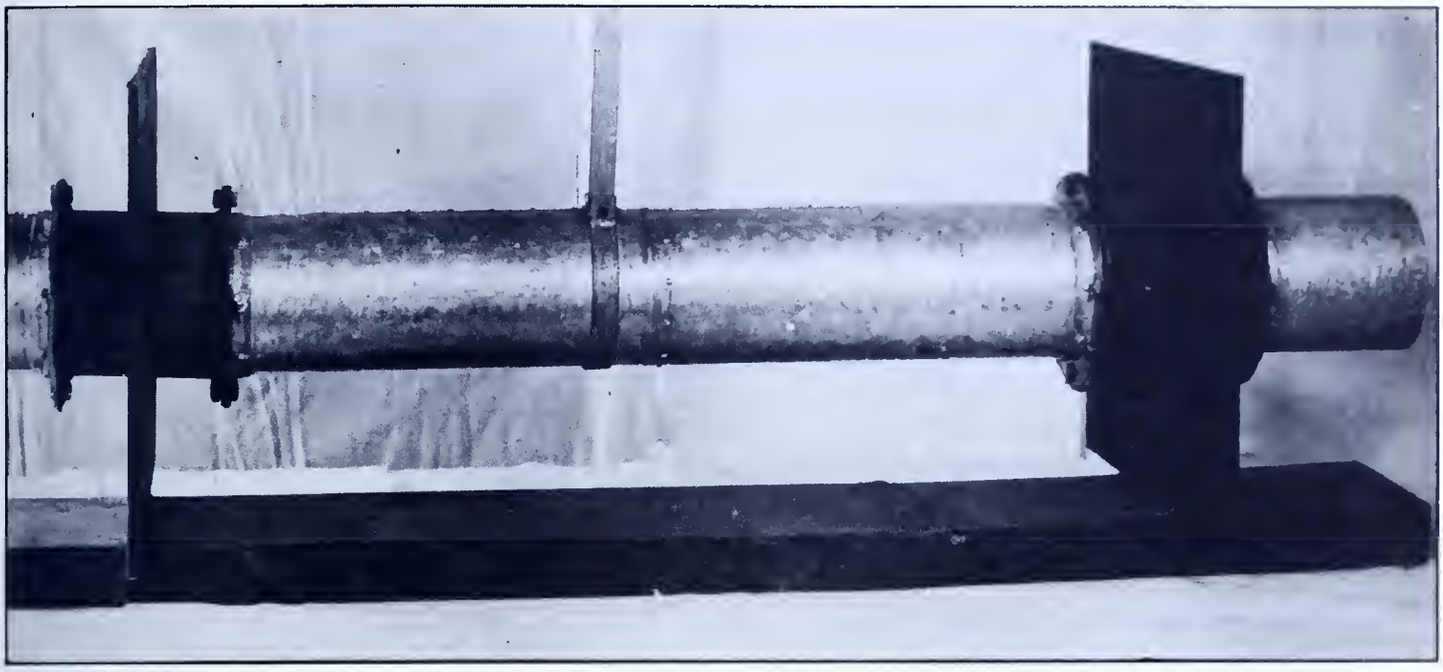


FIG. 4 - PATTERN LAYOUTS FOR JOBS 9a, 9b, 9c

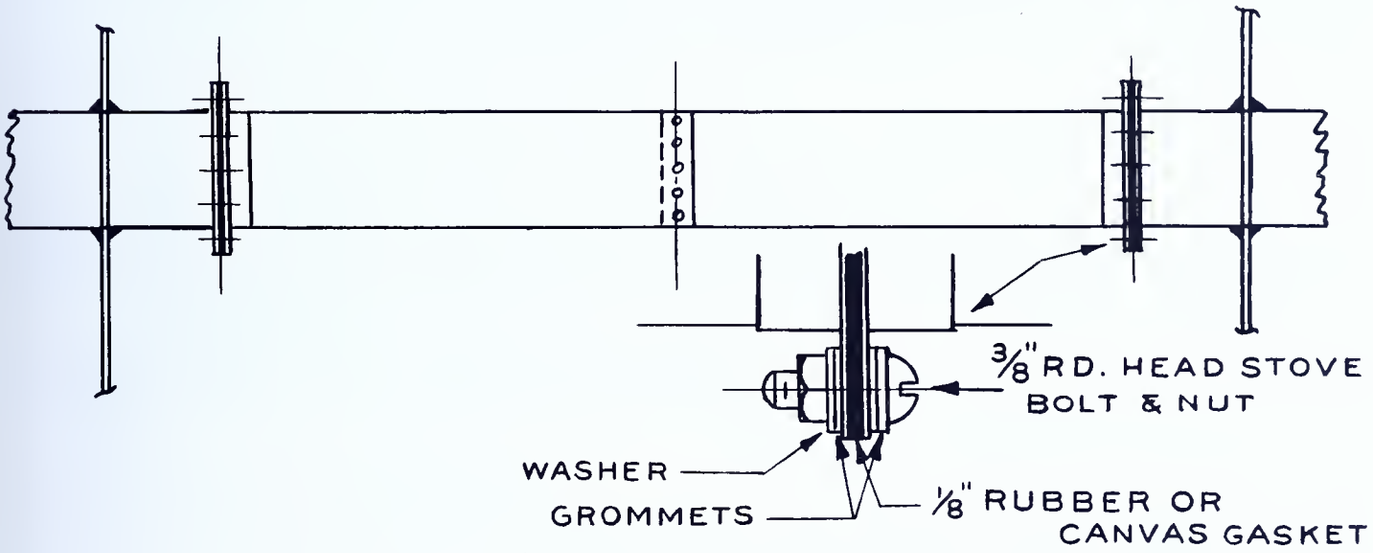
ASSEMBLE PIPE SECTIONS AND FIT TO SPOOLS

Objectives:

1. To become familiar with types of flanges and spool connections.
2. To learn how to assemble pipe joints.
3. To learn how to assemble flanges to pipe.
4. To learn how to assemble flanged joints.
5. To learn how to test for fume tightness.



ASSEMBLY OF PIPE BETWEEN SPOOLS



JOB. 10 – ASSEMBLY OF PIPE BETWEEN SPOOLS

General Information:

Marine sheet metal practice requires that joints of pipe be fastened by means of bolted flanges to spools where the pipe passes through bulkheads, longitudinals, or transverse framing. This construction is used both to support the pipe, and to provide means of removal in the event of repair or cleaning. The use of spool and doubler compensates for loss of strength of the member which was cut to permit passage of the pipe. Where lengths are unsupported by spools for a distance of approximately eight feet or more, hangers are used for support.

Specifications:

1. Jobs No. 1 and 2 to be assembled between spools.
2. Flanges, type "A" (Made from specifications in Job 4.)
3. Gaskets, 1/8" fabric insert rubber.
4. Grommets, to fit bolts.
5. Bolts, 3/8" galvanized.

Tools needed:

1. Wrench
2. Riveting hammer
3. Mallet
4. Rivet set size No.5
5. Scriber
6. Drift pin
7. Center punch
8. Dolly
9. Screw driver
10. Parker screws, No. 10
11. Hand drill, No. 28
12. Hollow punch for 3/8" bolt
13. Shears

Equipment needed:

1. Flanging fixture
2. Hollow mandrel or rail

Materials needed:

1. Rivets, size 4 lb.
2. 1/8" gasket rubber (One made in Job 5)
3. 3/8" bolts, nuts and washer.
4. Wicking for making grommets (Job 5)
5. Pipe joints fabricated in Job Nos. 1 and 2.

Procedure:

1. Secure pipe sections made up in Jobs Nos. 1 and 2.

2. Determine directions of air from plan or sketches. The small end of the pipe must be correctly placed in reference to the direction of air flow. Small end away from direction of flow.

3. Insert small end of one joint into large end of other joint, with seams together

4. Drift holes to line up.

5. Insert three or more sheet metal screws to hold joints in alignment.

6. Rivet joint by placing pipe on rail and inserting rivets from inside of pipe.

7. Solder riveted joint (joint between pipe sections).

8. Secure two standard 6" non-water-tight to water-tight flanges. (N.W.T to W.T.) (Previously made in Job No. 4)

9. Make flange gaskets to fit flange. Gaskets are made from 1/8" fabric-reenforced rubber, or from canvas. See Job 5.

10. Take assembled pipe run to place of installation aboard ship. (In the school shop, assemble the run in the dummy spool set up.)

11. Check length (L) of assembled pipe run with measurement between flanges of spools to which run must be fitted. If run of pipe is too long, trim to provide necessary clearance.

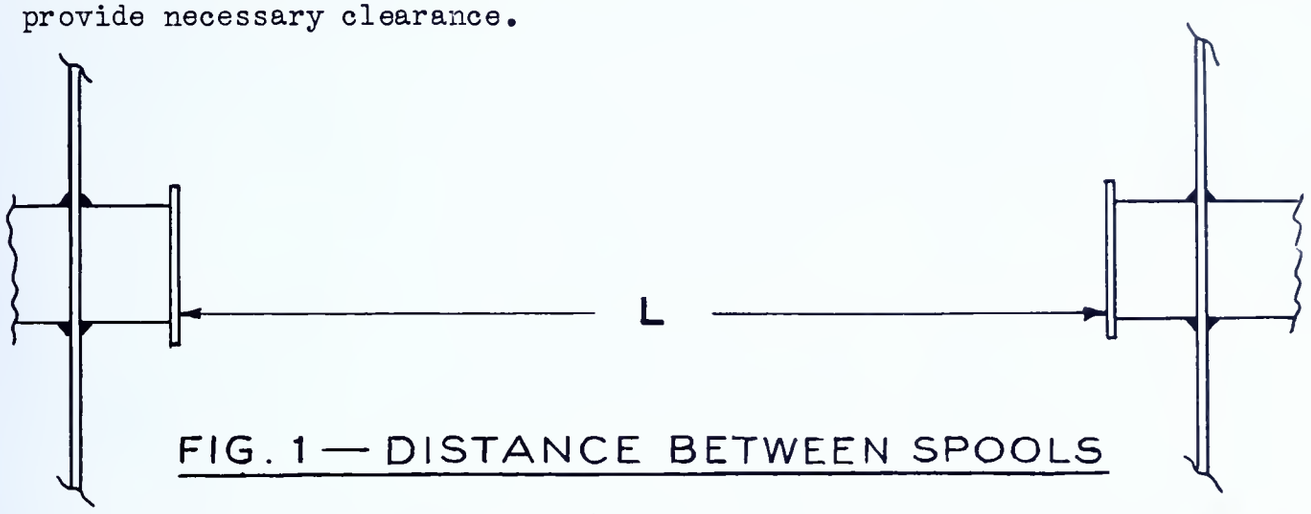


FIG. 1 — DISTANCE BETWEEN SPOOLS

The pipe should be trimmed 1/4" shorter than the distance "L" between flanges of spools to permit installation of gaskets.

12. Slide flanges on both ends of run of pipe. Do not fasten in place.

13. Adjust one flange on the pipe so that it is flush with the edge of the pipe, as illustrated at "a" in Fig. 2. With a pencil mark around pipe at toe of flange "b".

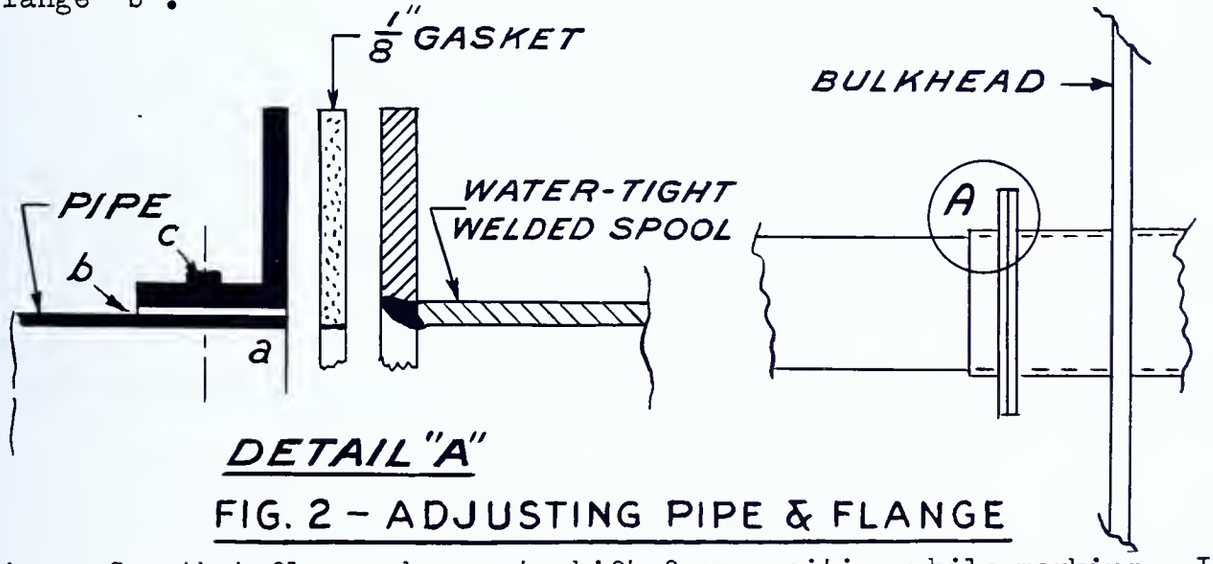


FIG. 2 - ADJUSTING PIPE & FLANGE

Caution: See that flange does not shift from position while marking. If necessary hold flange in position with "C" clamp while marking.

14. Secure eight spacers the same thickness as the gaskets (1/8"). These spacers, cut from 1/8" scrap, should be approximately 1" x 4".

15. Hold pipe in position of installation and turn seams to specified location. Seams usually are on top of pipe, or turned towards bulkhead, so as to be hidden from view.

16. Bolt the marked flange (Step 13) to spool flange, with spacers inserted between the two flanges to leave room for gasket.
There are many ways of arranging spacers. Fig. 3 shows one method.
Bolts should be drawn up finger tight (without grommets or washers.)

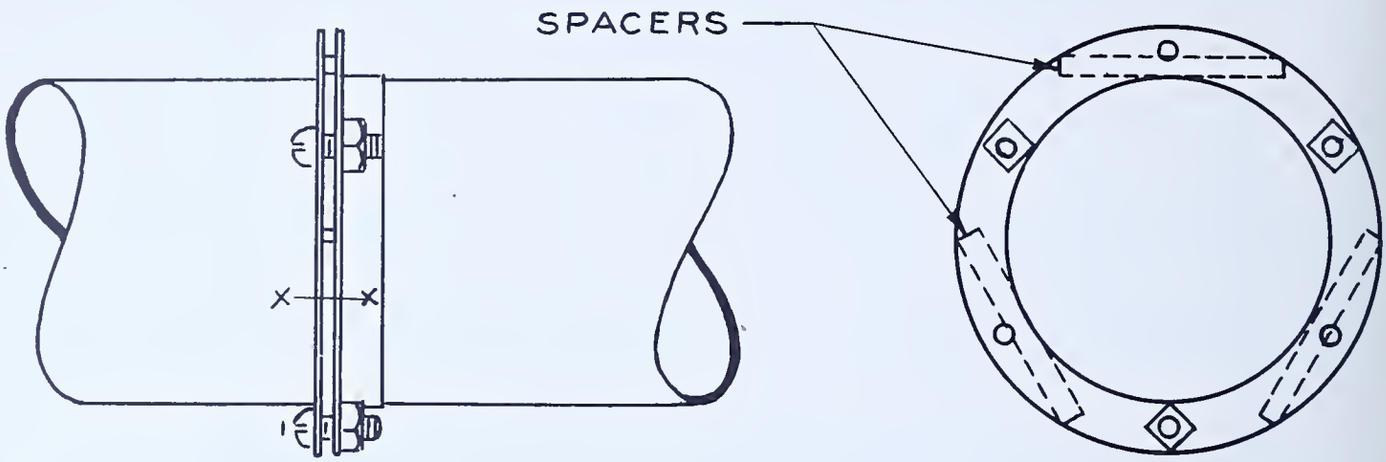


FIG. 3 - FLANGES & SPACERS

17. Temporarily bolt other flange in position, with spacers as indicated in Step 16.

18. Position pipe so that marking (placed on pipe in step 13) properly aligns with toe of flange.

19. Drill four holes and insert metal screws at each end of pipe, using flange holes as guides for drilling.
(Drill one hole, and insert a metal screw before drilling the next hole.)

20. Place a set mark across the faces of one flange assembly to insure return of run to same position, as shown at "x-x", in Fig. 3.

21. Remove bolts and spacers from both flanges, lowering pipe run to floor or working sufface.

22. Drill remaining holes (not occupied by metal screws) for specified rivets, and rivet.

23. Remove metal screws, drill, and rivet in these holes.

24. Solder flange toe ("b", Fig. 2) to pipe, and solder rivet heads ("c", Fig.2).

25. Tie gaskets to flanges of both spools using light cord.

26. Make grommets. See Job 5.
Note: Grommets may not be required if rubber gasket is used.

27. Place run in position, with set marks aligned.
On board ship, if work can not be painted after erection, the inaccessible parts of run must be painted by a ship painter before final erection.

28. Install bolts, washers, and grommets, and tighten nuts finger tight.

29. Uniformly tighten bolts and nuts.

30. Clean work.

31. Test assembly for fume tightness.. (Usually done after complete assembly.)

References:

1. Job 5 - Fabricate a Flange Gasket and Grommets.

2. Reference R - Air Test of Fume-Tight Vent Assemblies.

Questions:

1. Why should the pipe be trimmed 1/4" shorter than the distance between spools?
2. What determines the thickness of the spacers?
3. Why are spacers used?
4. How are seams usually located?
5. What is a "set mark"? What purpose does it serve?

FABRICATE RECTANGULAR DUCT WITH DOUBLE SEAM, PITTSBURGH LOCK, AND SLIP CONNECTION

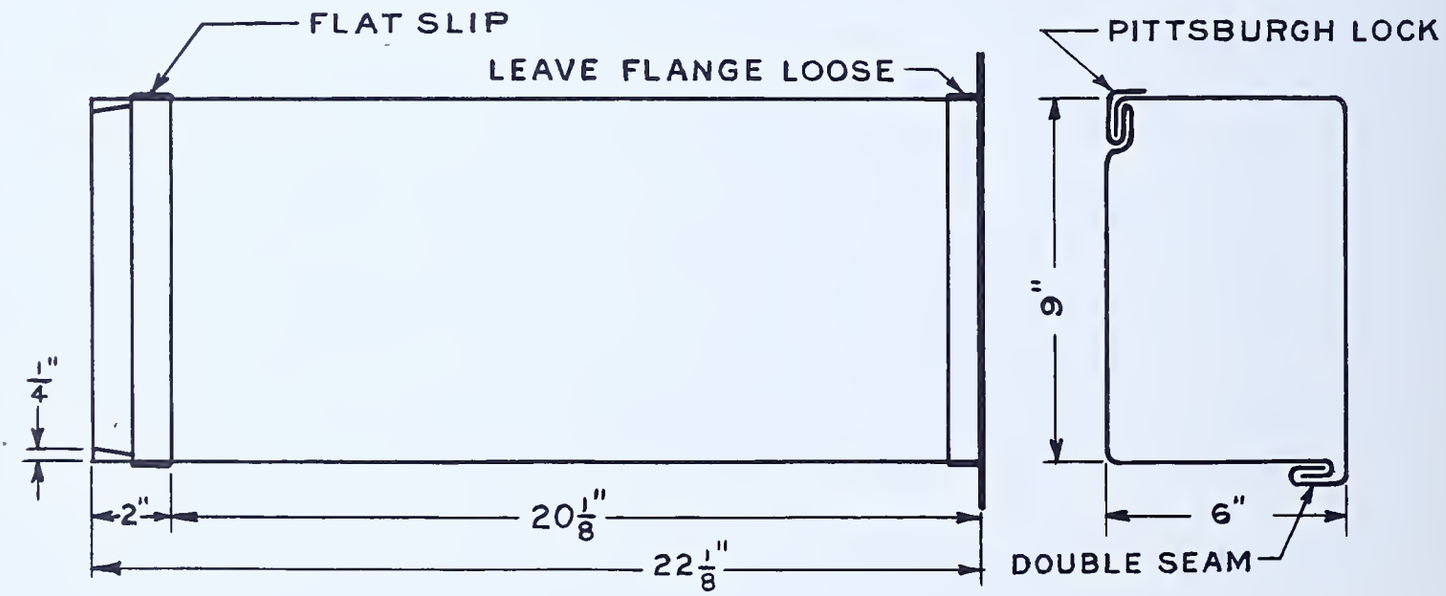
Objectives:

1. To become familiar with various types of seams.
2. To learn how to make a double seam.
3. To learn how to make a Pittsburgh lock seam.
4. To learn how to make a connecting slip.
5. To learn how to make a rectangular flange.

General Information:

Rectangular ducts are used extensively in merchant marine ventilation work and sometimes in naval ventilation. This job is to make a joint of rectangular duct, using two different methods of seaming. The joint will also have a flat slip riveted to it. This "slip" provides a means of connecting the next joint. The "slip", while used in merchant marine work, is not preferred for naval work. Ways of seaming rectangular ducts together are shown in Reference "F", "Description of Rectangular Pipe Seams".

RECTANGULAR DUCT WITH FLANGE
(SLIP OMITTED)



JOB 11 — RECTANGULAR DUCT

Specifications:

1. Size, 6" x 9".
2. Seams, double seam and Pittsburgh lock, both soldered.
3. Gauge, 24 (.025) galvanized sheet steel.
4. Slip joint.

Tools needed:

1. Scriber
2. Rule
3. Square
4. Straight shears
5. Mallet
6. Riveting hammer
7. Dolly
8. Soldering coppers (2)
9. Pliers
10. Metal gauge
11. Hand punch No. 5

Equipment needed:

1. Square shear
2. Cornice brake
3. Beakhorn stake
4. Gas furnace

Materials needed:

1. Two pieces of 24 gauge (.025) galvanized sheet steel approximately 17" x 22-1/2" and one piece approximately 5" x 32".
2. Bar solder, half and half.
3. Tinners' rivets, 2 lb. size.

Procedure:

1. Square shear one piece 15-13/16" x 22-1/8" and mark it "X". Square shear one piece 16-1/8" x 22-1/8" and mark it "Y". Square shear one piece 4" x 31-3/4" and mark it "Z" (piece for flat slip).

   Owing to different allowances for the two parts of the two types of seams, pieces "X" and "Y" must be identified. Piece "Y" includes allowance for single edge of double seam (B^1) and pocket (A^2) of Pittsburgh lock seam.

   Piece "X" when seamed together with piece "Y" make up the rectangular pipe. This unit combining both seams is for teaching purposes. In practice similar seams are followed on the same piece, if they were unable to make a complete pipe from one piece of metal.

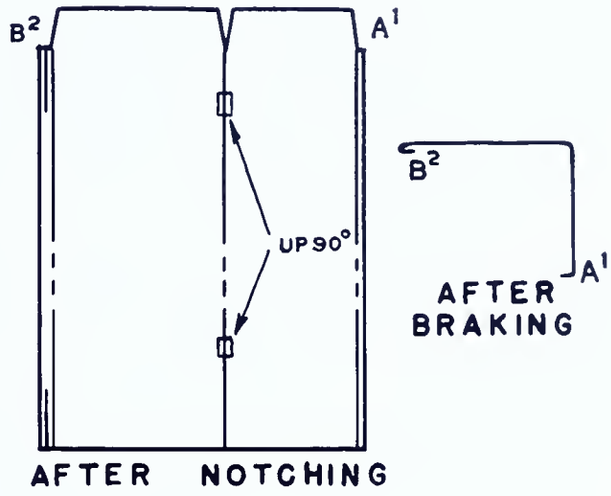


FIG. 1 — PIECE "X"

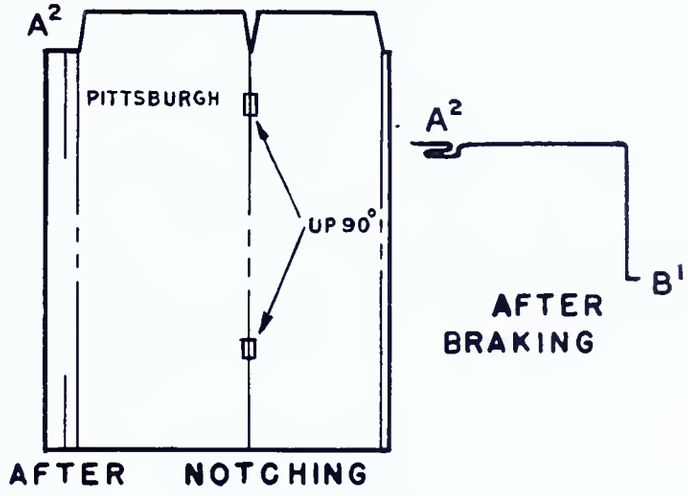
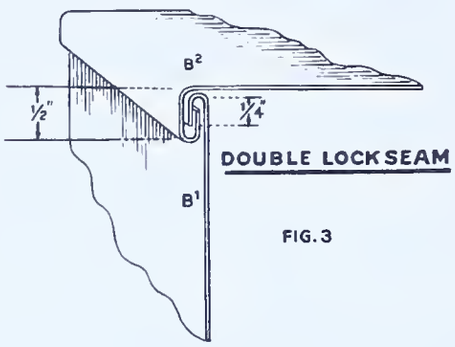


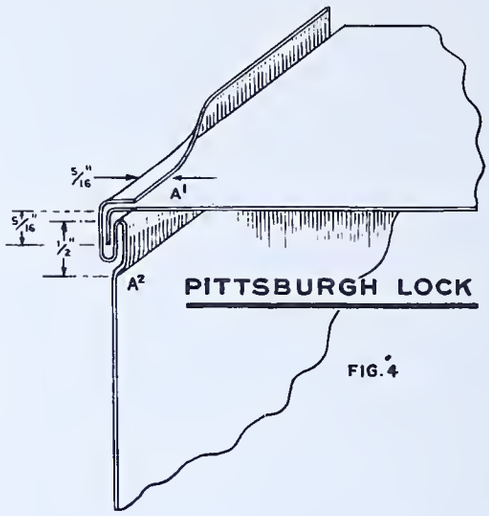
FIG. 2 — PIECE "Y"

2. Lay out from pattern or shop sketch pieces "X" and "Y".



DOUBLE LOCKSEAM

FIG. 3



PITTSBURGH LOCK

FIG. 4

3. Notch pieces "Z" and "Y" with hand shears as indicated on pattern layout. The layout shows the dimensions for correct notching of the pipe, so as to provide clearance for the corners of the slip. It would be very difficult to attach the slip to the pipe if extra thicknesses of metal at the pipe seams, in the way of slip, were not cut out.

4. Form Pittsburgh lock on piece "Y".

5. Form remaining bends of piece "Y" on cornice brake. Fig. 2.

5. Form all bends of piece "Z" (Fig. 1) on the cornice brake.

7. Hook "X" and "Y" together and complete double seam. (B^1-B^2) Fig. 3.

8. Complete Pittsburgh lock. (A^1-A^2) Fig. 4.

9. Make a flat slip from "Z".

10. Rivet slip to pipe.

11. Make a flange.

12. Rivet flange to pipe.

13. Solder fume-tight.

14. Rinse piece with water and wipe with waste.

References:

1. See References for Job 11.
2. Reference "G" - "Double Seaming"
3. Reference "H" - "Pittsburgh Lock Seams"
4. Reference "E" - "Description of Flanges"
5. Job 4 - "How to Make a Flange"
6. Job 12 - "How to Make a Flat Slip"

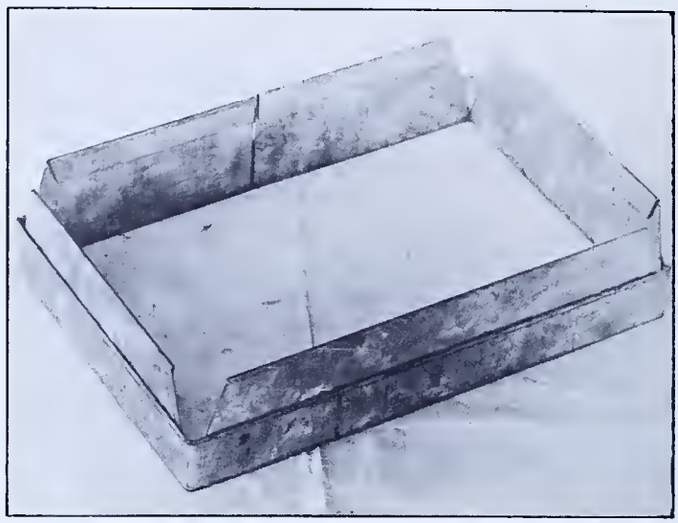
Questions:

1. Why does a "double seam" have to be placed on a corner of a pipe?
2. What determines the kind of seam used on sheet metal pipe?
3. When scribing the outline of a pattern, why should the scriber have a long tapered point?
4. Why is it necessary that a sharp punch be used when marking the brake line points and centers of holes?

FABRICATE A FLAT SLIP

Objective:

1. To learn how to form a Flat Slip.



FLAT SLIP

General Information:

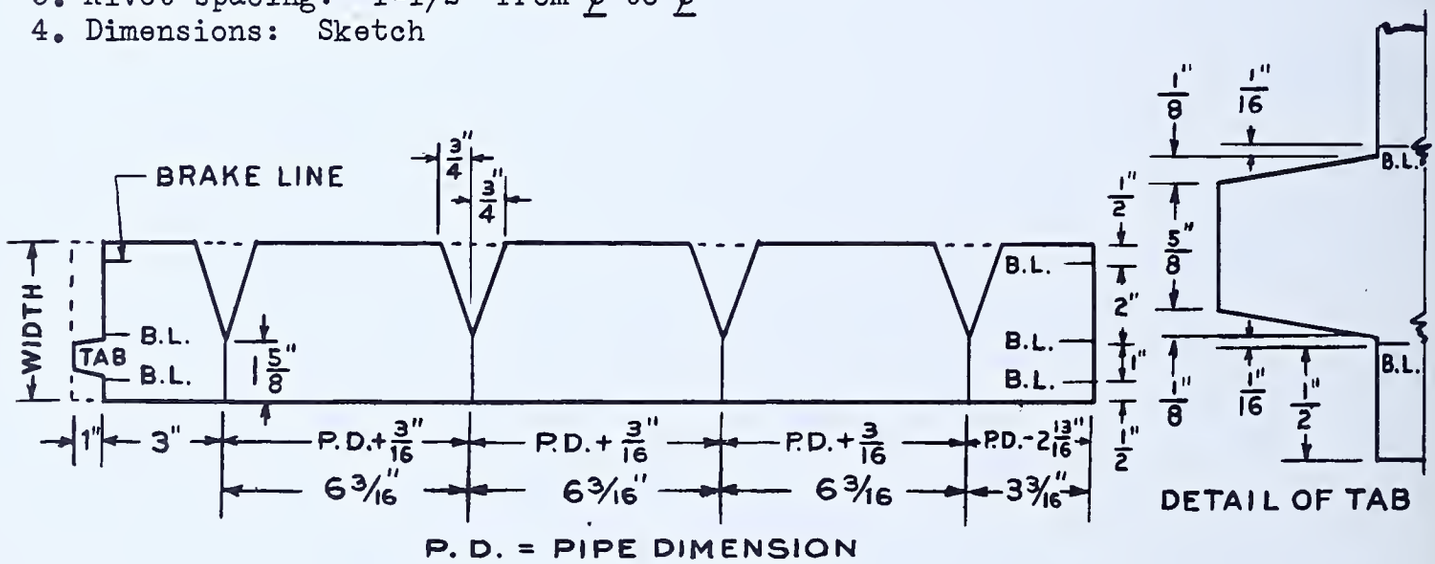
A slip is a means of connecting one joint to another. The width of the slip blank is 4". Fig. 1. This is an accepted standard in most shops.

The length is determined by adding 1-1/2" to the sum of the sides. This allowance provides for clearance so that the slip may pass over the outside of the pipe and also includes metal for the tab.

Example: The length for a blank to make a slip for a pipe 6" x 6" would be 6+6+6+6 or 24 inches, plus 1-3/4" totaling 25-3/4 inches, then the blank dimension for the slip would be 4" x 25-3/4".

Specifications:

1. Metal: 22 gauge (.031)
2. Rivets: 4 lb. tinners'
3. Rivet spacing: 1-1/2" from ℄ to ℄
4. Dimensions: Sketch



P. D. = PIPE DIMENSION

JOB. 12 PATTERN FOR A FLAT SLIP

Tools needed:

1. Scriber
2. Combination square
3. Metal gauge
4. Riveting hammer
5. Rivet set (No. 3)
6. Mallet
7. Center punch
8. Straight snips
9. Hand punch No. 5

Equipment needed:

1. Squaring shears
2. Brake
3. Drill
4. Square head stake

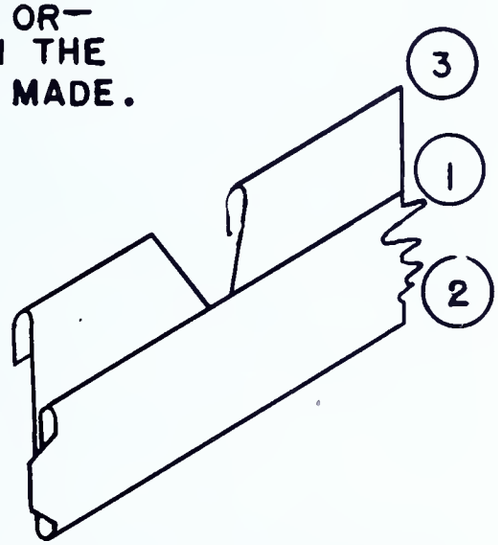
Materials:

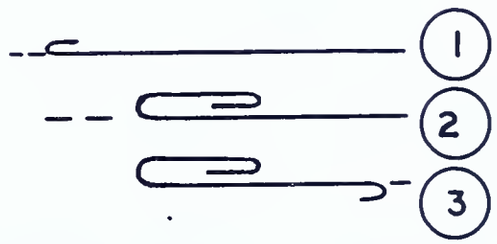
Piece of 22 gauge metal to suit.

Procedure:

1. Secure pattern (or develop pattern as directed). Specification Sketch.
2. Study specifications of job.
3. Select scrap or stock metal of required gauge.
4. Measure pattern and block out metal to size needed on square shear.
5. Transfer pattern to metal.
6. Cut and notch slip.
7. Deburr edges.
8. Brake up slip as shown in Fig. 1.

"TAB" END OF SLIP AFTER BRAKING SHOWING THE ORDER IN WHICH THE BENDS WERE MADE.





BRAKE & FLATTEN IN THE ABOVE ORDER.

FIG. 1 — BRAKING DETAIL

9. Support the corners one at a time on the edge of a square head stake as shown in Fig. 2 and crease the metal with a mallet blow.

10. Bend the slip by hand to the same shape as the pipe or fitting and insert the tab into opposite end thus completing the slip as shown in Fig. 3.
Note: Slip is fastened to duct as shown with flush rivet. Ducts are joined together with screws in Fig. 3.

Corner Bends

Support the corners one at a time on the edge of a square stake as shown in Fig. 2, and crease the metal with a mallet. By hand, bend the slip to the same shape as the pipe or fitting and insert the tab into opposite end thus completing the slip as shown in Fig. 3.

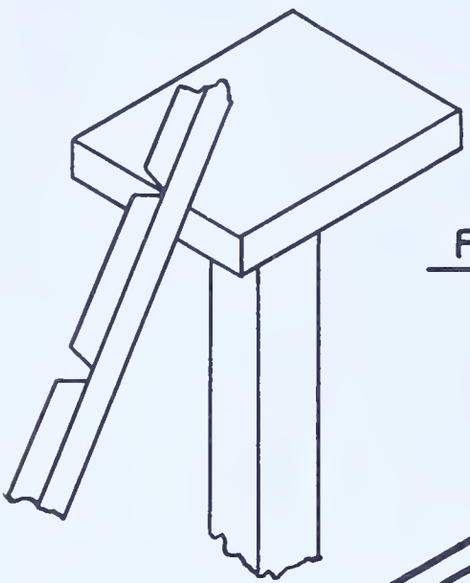


FIG. 2 — BENDING CORNERS

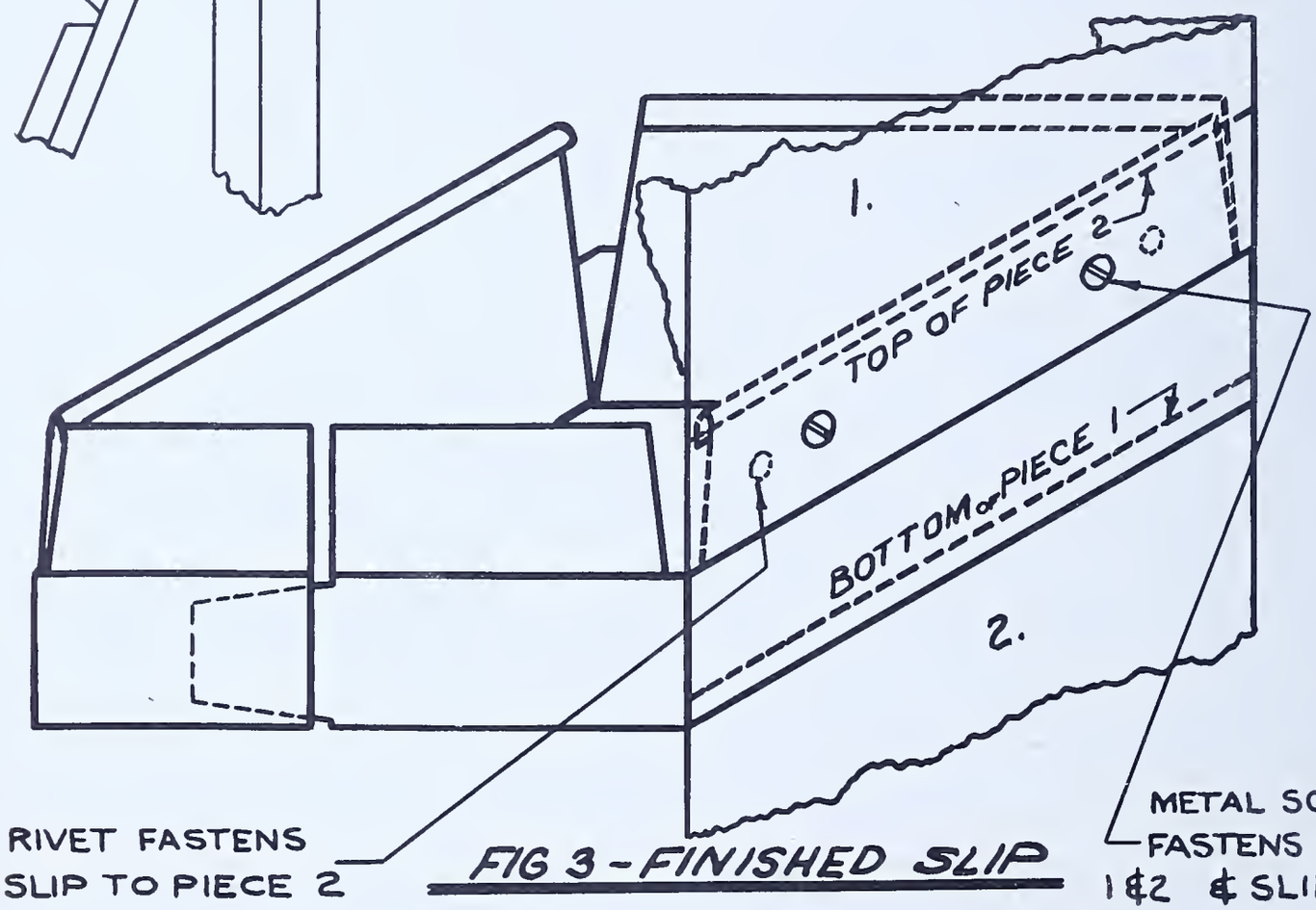


FIG 3 - FINISHED SLIP

FABRICATE A JOINT OF FLAT-OVAL PIPE

Objectives:

1. To learn how to lay out a joint of flat-oval pipe.
2. To learn how to fabricate a joint of flat-oval pipe.
3. To learn how to use a template in determining the shape of pipe.
4. To learn how to make a flat-oval flange.

FLAT OVAL PIPE

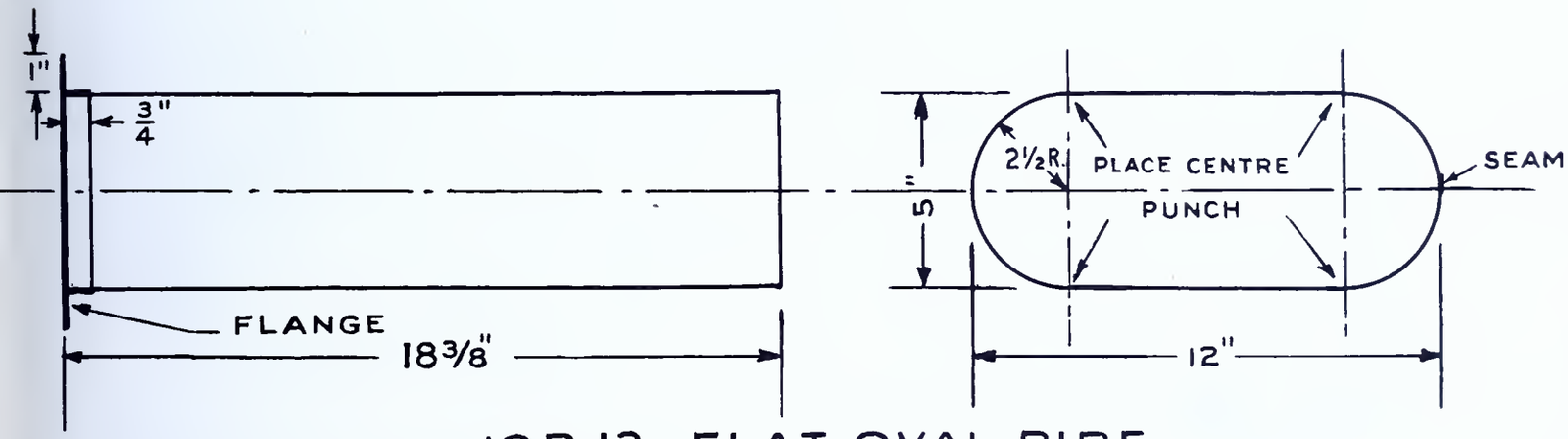
General Information:

Riveted and soldered seams are used in naval work where the section must be fume-tight, but not water-tight. Riveted seams are used in fabricating small and large diameter pipe, from approximately 26-gauge to 16-gauge.

Flat-oval pipe is widely used in naval construction where head room must be maintained, or where ventilation ducts must clear obstructions.

Specifications:

1. Dimensions, 5" x 12" F.O. x 18-3/8" long.
2. Seams riveted and soldered.
3. Rivet spacing approximately 2" ℄-℄ for joint and seams.
4. Seam rivet landing, 3/8".
5. Metal: 16 gauge (.062) galvanized sheet steel.



JOB 13—FLAT OVAL PIPE

Tools needed:

1. Riveting hammer
2. Rivet set, size No. 3
3. Rule
4. Center punch
5. Scriber
6. Mallet
7. Straight hand shear
8. Metal gauge
9. Square
10. Hand punch No. 5
11. Soldering coppers (2)

Equipment needed:

1. Brake
2. Square shear
3. Slip roll
4. Rail
5. Gas furnace
6. Lever shear

Materials needed:

1. Two pieces 16-gauge (.062) galvanized sheet steel approximately 16" x 19".
2. Tinners' rivets, size 4 lb.
3. Bar Solder, half and half.

Procedure:

1. Study specifications.

2. Secure pattern (or lay out pattern as directed).

3. Secure proper size and gauge of metal from scrap or stock.

4. Transfer pattern of sheet metal, including dimensions, laps, and rivet holes.

   Good fabrication practice requires that rivet holes be laid out and punched "in the flat" (before shaping or forming) in both ends of pipe joints. This procedure permits more rapid assembly of pipe sections with little opportunity for mis-alignment of joints, providing the layout is carefully and accurately done.

   Rivet holes on the end of a pipe to which a flange is attached are omitted until the flange is assembled to the pipe.

5. Cut and notch small end of piece with shears.

6. Punch rivet holes.

7. Cut a template of required pipe size from scrap metal.

   In fabricating a flat-oval pipe, a template, of correct size and shape (the cross section of the required pipe) is first laid out on scrap metal and then cut to shape. Two or three 1" diameter holes are cut in the template to assist in inserting and removing the template from the pipe as in Fig. 1.

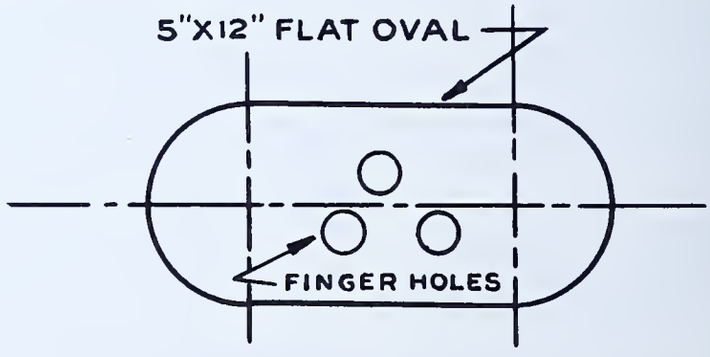


FIG. 1 - PIPE SHAPE TEMPLATE

8. Form pipe on slip rolls to shape of template.

9. Rivet formed sections on rail or hollow mandrel.

10. Dress seam with mallet and check pipe with template.

11. Make a flat oval flange similar to circular flange of Jobs 3 and 4.

12. Solder seams.
Note: If joint is properly soldered, rivets will be soldered also.

13. Rinse off with water all remains of soldering flux and wipe dry with waste.

References:

1. References for Job 13.
2. Reference E - Description of Flanges.
3. Job 4 - Fabricate a Flange (N.W.T. to W.T)

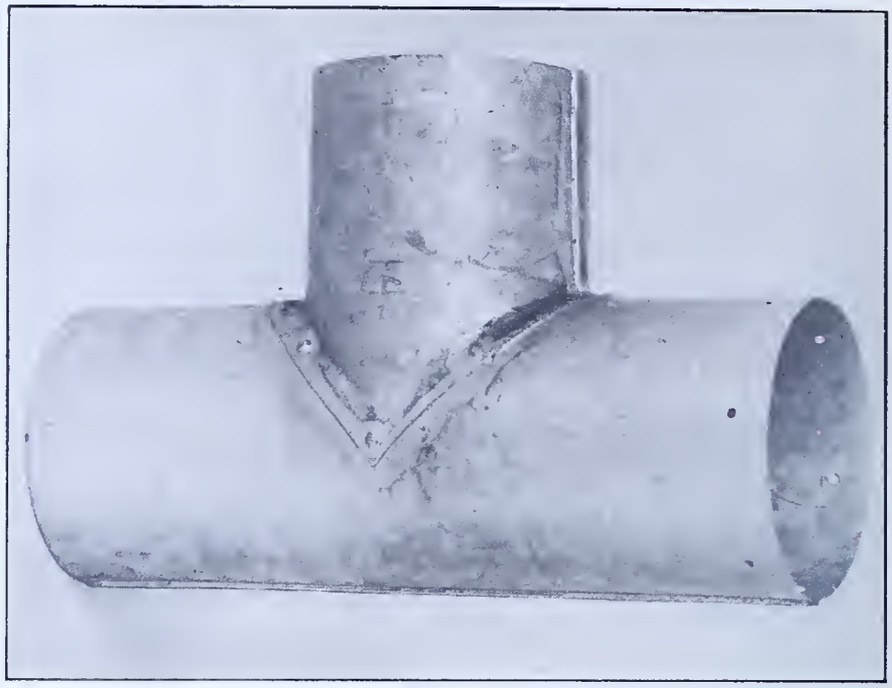
Question:

1. Why is it necessary to use a pipe shape template?

FABRICATE A 90 DEGREE T-COLLAR, DIAMETERS EQUAL

Objectives:

1. To learn how to fabricate a T-collar.
2. To learn how to apply parallel line development in sheet metal layout.
3. To learn how to use sheet metal markers.



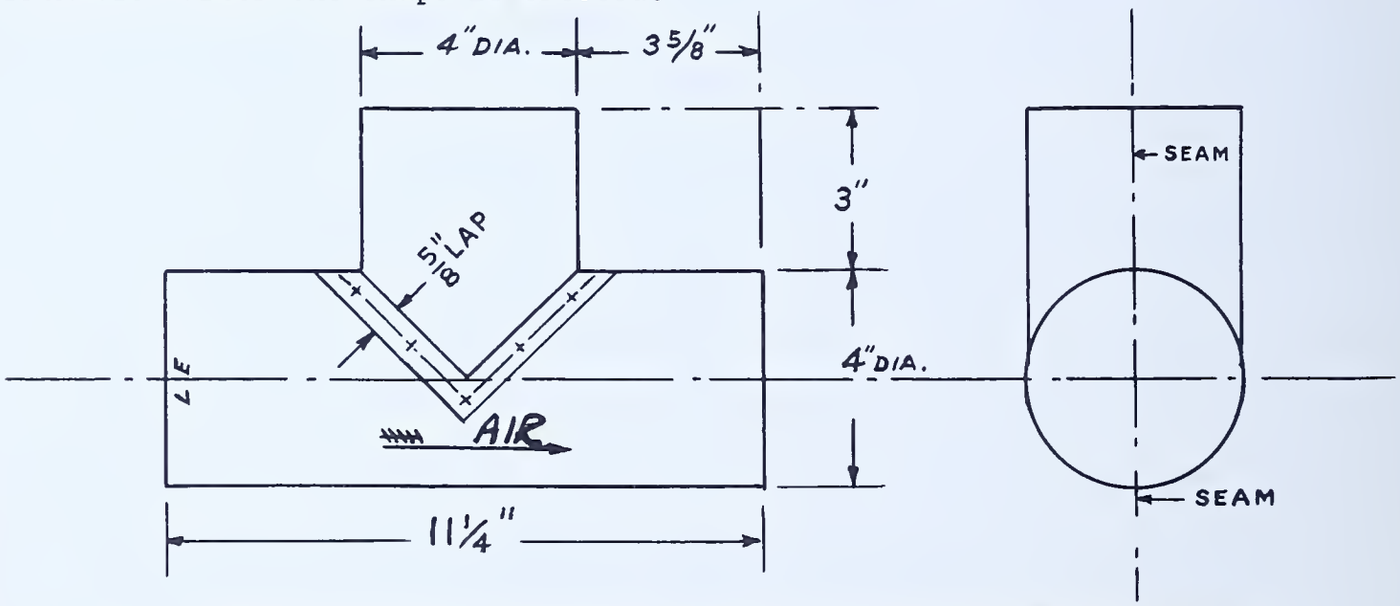
90° T-COLLAR

General Information:

Of all sheet metal ventilation shapes, perhaps the T-collar is the simplest to lay out and construct. Although the T-collar with equal diameters is not widely used in marine sheet metal, this job is presented so that the student may have an opportunity to work with this type of fabrication in its less difficult form. The hole for the collar is not laid out from the pattern but scribed from the collar after the shapes are made.

The T-collar frequently is used where a cleanout is necessary, such as a smoke breeching.

The position of seams are such that, where possible, they will be hidden from view after the shape is erected.



JOB 14 — 90° TEE COLLAR, DIAMETERS EQUAL

Specifications:

1. Dimensions, 4" diameter collar on 4" diameter pipe.
2. Seams; grooved and soldered.
3. To be laid out with small end.
4. Rivet spacing for joint to be approximately 2".
5. Metal, 24 gauge (.025) galvanized sheet steel.
6. Lay out and punch holes in large end only.

Tools needed:

1. Metal gauge
2. Groover, Size No. 2
3. Riveting hammer
4. Stretching hammer
5. Rivet set, size No. 6
7. Aviation hand shear
7. Center punch
8. Straight hand shears
9. Circular hand shears
10. Hand punch, No. 5
11. Rule
12. Soldering coppers (2)
13. Square
14. Scriber
15. Mallet

Equipment needed:

1. Square shear
2. Brake or bar folder
3. Mandrel or Cylindrical Stake
4. Slip roll former
5. Burring machine
6. Turning machine
7. Gas furnace

Materials needed:

1. Rivets, size 1-1/2 lb.
2. One piece galvanized sheet steel No. 24 gauge (.025) approximately 12" x 14".
   One piece galvanized sheet steel No. 24 gauge (.025) approximately 6" x 14".
3. Bar solder, half and half.

Procedure:

1. Secure pattern from layer-out (or develop pattern as directed).

2. Study specifications of job.

3. Select scrap or stock metal of required gauge.

4. Measure pattern and "block out" to sizes needed on square shear.

5. Transfer pattern to metal.

6. Cut out collar, using straight and circular hand shears. Use aviation snips to cut hole in pipe blanks. (Layout time is saved by eliminating the laying out of the hole in pipe as follows:)*

   Alternate procedure when pipe is not laid out:
   a) Fabricate pipe
   b) Fabricate collar including flanging and punching rivet holes.
   c) Place collar on pipe at designated location.
   d) Mark inside and outside of flange on pipe.
   e) Mark rivet hole locations.
   f) Cut out hole in pipe, leaving an allowance for dressing edge of pipe on the collar.
   g) Rivet collar and pipe together.

   *In practical work this method is standard.

7. Punch or drill holes for rivets.

8. Deburr edges.

9. Fold edges to be grooved on brake or bar folder.

10. Form pipe and collar to correct diameter, using slip roll.

11. Groove seam, on a cylindrical stake or hollow mandrel.

12. Scribe off correct size flange on outside of collar using a marker.

13. Start flange on collar using a turning machine or a burring machine, as determined in shop practice.

14. Stretch collar flange to fit pipe.
    Note: The entire width of flange must bear on pipe. This can be determined by holding pipe and collar together. In stretching the flange the collar is placed upon a squarehead stake and hammered with peening end of a riveting hammer. Whenever flanging or working metal always hammer or mallet the metals throughout the length of the flange just a little bit at a time to prevent splitting, and then repeat the operations, bringing the metal up a little each time, repeating until the flange is fully formed.

15. Rivet collar and pipe together.

16. Stretch metal allowed for flange of pipe to fit snugly against inside of collar.

17. Check both ends of pipe and collar for specified shape and size.

18. Solder fume-tight.

19. Rinse off flux with water and wipe dry with waste.

References:

1. References for Job 14.
2. Reference "O" - How to Make and Use Sheet Metal Markers.

Questions:

1. Could one use the same pattern if the specification had indicated that sixteen gauge galvanized-iron be used? Explain.
2. What is the operation called that is done on the turning machine before flanging or bending up an edge by hand?
3. Why is scoring or creasing done on the turning machine instead of the burring machine?

FABRICATE A 45° COLLAR, DIAMETERS EQUAL

Objective:

1. To learn how to fabricate a 45° collar.

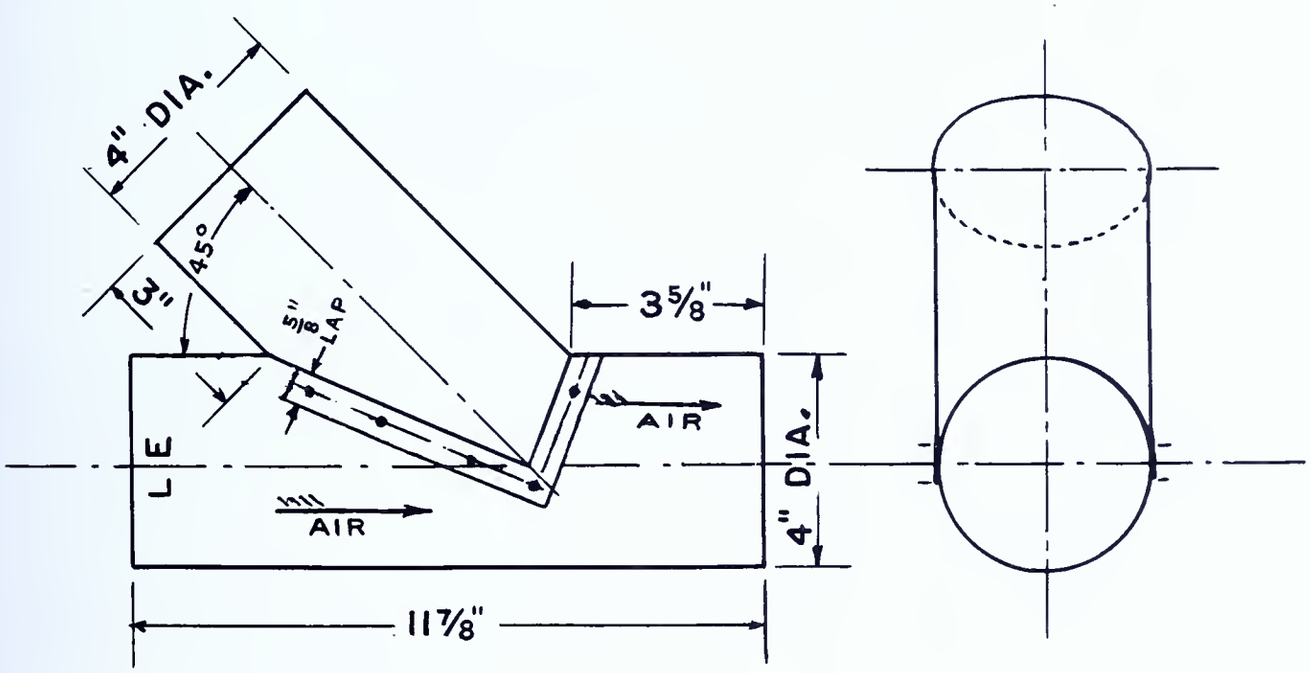
45° COLLAR

General Information:

To provide a unit of less difficulty, this job specifies a 45 degree collar having the same diameter as the pipe; although a 45 degree collar with different diameters is more frequently used in marine installations.

Specifications:

1. Metal: 24 gauge (.025) galvanized sheet steel.
2. Seams to be grooved and soldered.
3. To be laid out with a large end.
4. Rivet spacing for joint to be approximately 2" ℄ - ℄.
5. Lay out and punch rivet holes in large end of pipe only.
6. Standard lap allowance.



JOB 15. — 45° COLLAR, DIAMETERS EQUAL

Tools needed:

1. Metal gauge
2. Scriber
3. Straight shear
4. Circular hand shear
5. Aviation shear
6. Groover, No. 2
7. Mallet
8. Center punch
9. Rivet set, size No. 6
10. Square
11. Riveting hammer
12. Hand punch (#5)
13. Soldering coppers (2)
14. Rule
15. Dolly Bar

Equipment needed:

1. Square shear
2. Brake or bar folder
3. Mandrel or cylindrical stake
4. Slip roll former
5. Gas furnace
6. Edging or burring machine

Materials needed:

1. One piece 24 gauge (.025) galvanized sheet steel approximately 12-1/2" x 14".
   One piece 24 gauge (.025) galvanized sheet steel approximately 10" x 14".
2. Rivets, size 1-1/2 lb.
3. Bar solder, half and half.

Procedures:

1. Secure pattern from layer-out (or develop pattern as directed).
2. Study specifications of job.
3. Select scrap or stock metal of required gauge.
4. Measure pattern and block out to sizes needed on square shear.
5. Transfer pattern to metal.
6. Cut out collar using straight and circular hand shears.
7. Fold edges to be grooved.
8. Form pipe and collar.
9. Groove seams on stake of hollow mandrel.
10. Shape to correct dimensions.
11. Start flange on collar using a turning machine.
12. Stretch collar flange to fit pipe.
13. Lay-out and punch rivet holes on collar flange.
14. Place collar in position on pipe and mark collar opening and rivet holes.
15. Mark allowance for "knockover" where throat of collar joins pipe.
16. Cut out the opening for collar.

17. Notch throat for "knockover".

18. Center punch mark rivet holes.

19. Punch rivet holes with hand punch.

20. Deburr edges.

21. Rivet collar and pipe together.

22. Turn "knockover" lip in throat of collar.

23. Dress pipe and collar closer using dolly bar and hammer.

24. Solder fume-tight.

25. Rinse off all remains of flux with water and wipe dry with waste.

References:

1. Reference O - How to Make and Use Sheet Metal Markers

2. References for Job 15

Questions:

1. Why is this type collar used rather than a "T-Collar"?
2. What is the purpose of the "knockover"?
3. Why do we notch the knockover?

FABRICATE A 30° COLLAR, DIAMETERS UNEQUAL

Objective:

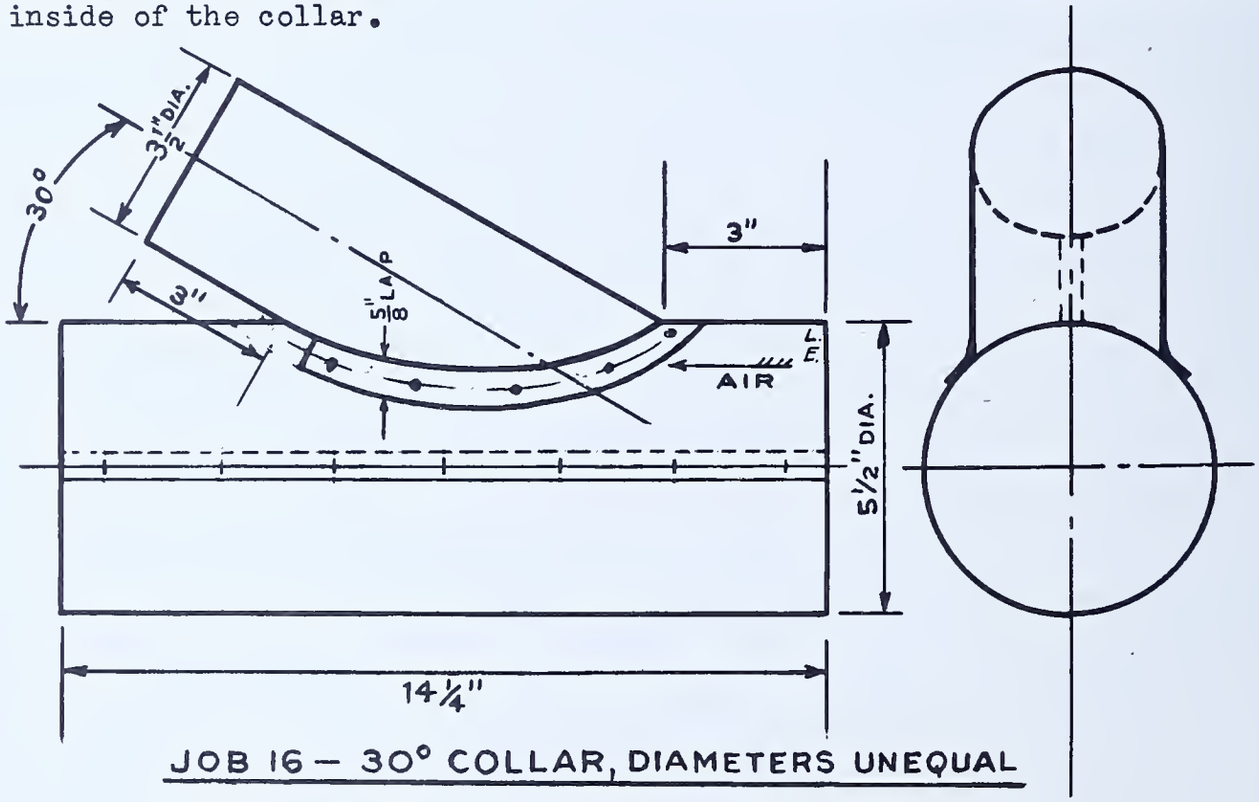
1. To learn how to fabricate a 30° collar, diameters unequal.

General Information:

Most marine applications of collars involve the use of a collar of smaller diameter than the main pipe. In fabricating this job, made of galvanized sheet steel, riveting is used to fasten the collar to the pipe.

In naval construction aluminum frequently would be used, instead of the galvanized steel specified. The joint between the collar and the pipe would be painted with zinc chromate or other specified paint. After this paint is dry the contacting or "faying" surfaces are daubed with a specified compound before riveting. The protruding edge of the pipe is then flanged snugly against the inside of the collar.

30° COLLAR



JOB 16 — 30° COLLAR, DIAMETERS UNEQUAL

Specifications:

1. Collar to be riveted to pipe.
2. Metal: 20 (.038) and 24 gauge (.025) galvanized sheet steel.
3. Dimensions 3-1/2" diameter collar on 5-1/2" diameter pipe.
4. Seams on pipe to be riveted about 2" ℄ - ℄ with 3/4" landing, 3/8" lap.
5. To be laid out with large end as shown.
6. Rivet spacing for joint to be approximately 2" centers 3/4" landing.
7. Collar seam to be grooved.
8. All seams to be soldered.
9. Standard lap allowance.

Tools needed:

1. Metal gauge
2. Scriber
3. Straight hand shears
4. Circular hand shears
5. Groover
6. Mallet
7. Center Punch
8. Rivet Set
9. Square
10. Rivet Hammer
11. Dolly Bar
12. Hand Punch
13. Soldering coppers (2)
14. Rule
15. Aviation shears

Equipment needed:

1. Square Shear
2. Brake or bar
3. Mandrel or cylindrical stake
4. Slip roll former
5. Gas furnace
6. Edging or Burring Machine

Materials needed:

1. Metal for pipe; 20 gauge (.038) 1 piece approximately 15" x 19".
   Metal for collar; 24 gauge (.025) 1 piece approximately 7" x 12".
2. Rivets: size 2 lb.
3. Bar solder.

Procedures:

1. Secure pattern from layer-out (or develop patterns as directed).

2. Study specifications of job.

3. Select scrap or stock metal of required gauge.

4. Measure pattern and block out to sizes needed on square shears.

5. Transfer pattern to metal.

6. Cut out collar using straight and circular hand shears.

7. Fold edges to be grooved.

8. Form pipe and collar.

9. Groove seams on stake or hollow mandrel.

10. Shape to correct dimensions.

11. Start flange on collar using a turning machine.

12. Stretch collar flange to fit pipe.

13. Lay-out and punch rivet holes on collar flange.

14. Place collar in position on pipe and mark collar opening and rivet holes.

15. Mark allowance for "knockover" where throat of collar joins pipe.

16. Cut out the opening for collar.

17. Notch throat for "knockout".

18. Center punch mark rivet holes.

19. Punch rivet holes with hand punch.

20. Deburr edges.

21. Rivet collar and pipe together.

22. Turn "knockover" lip in throat of collar.

23. Dress pipe and collar closer using dolly bar and hammer.

24. Solder fume-tight.

25. Rinse off all remains of flux with water and wipe dry with waste.

Questions:

1. What metal is used most frequently in cruiser ventilation pipe?
2. How are contacting surfaces of aluminum treated before riveting?
3. Why is an extra view required when laying out a collar with different diameters as compared with a collar having equal diameters?

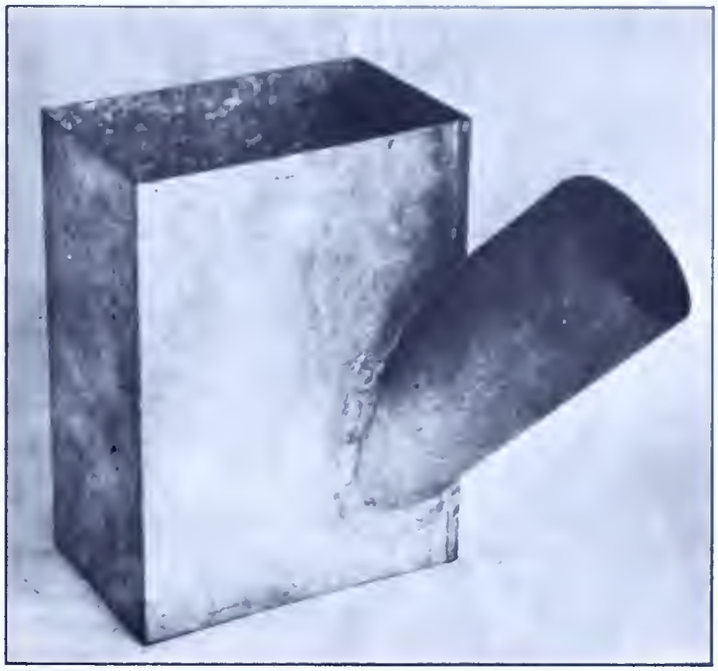
FABRICATE A 45° CIRCULAR COLLAR ON CORNER OF RECTANGULAR DUCT

Objectives:

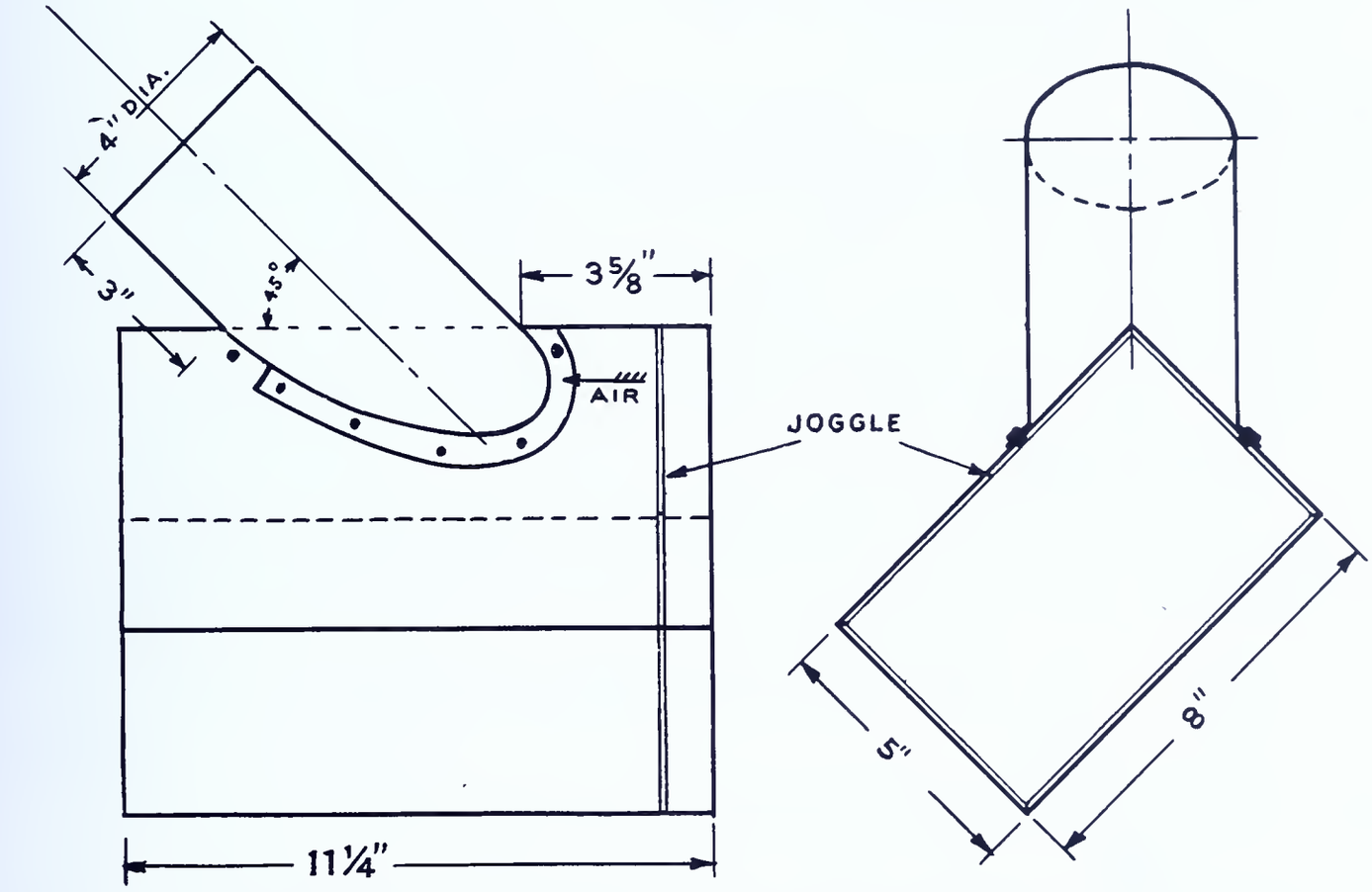
1. To learn how to fabricate a 45° circular collar on the corner of a rectangular duct.
2. To learn how to make a "joggle".

General Information:

This type of fitting is often used to connect a branch to a rectangular duct where the head room is limited, or to connect a rising branch that protrudes through a lighting hole in girder.



45° CIRCULAR COLLAR ON CORNER OF RECTANGULAR DUCT



JOB 17-45° COLLAR ON CORNER OF RECTANGULAR DUCT

Specifications:

1. Dimensions: 4" diameter pipe on a 5" x 8" rectangular duct.
2. Metal: 22 gauge (.031) galvanized sheet steel.
3. Seams: collar, grooved; duct, double seamed.
4. Collar riveted to duct, approximately 2" ℄ - ℄ spacing.
5. Solder fume-tight.
6. Standard lap allowance.

Tools needed:

1. Scriber
2. Center punch
3. Square
4. Riveting hammer
5. Mallet
6. Rivet set No. 5
7. Hand punch No. 5
8. Metal gauge
9. Soldering coppers
10. Straight hand shears
11. Circular hand shear
12. Aviation hand shear
13. Groover
14. Tape rule

Equipment needed:

1. Square shear
2. Brake
3. Slip roll
4. Beakhorn stake
5. Gas furnace
6. Hollow mandrel
7. Turning machine
8. Square head stake

Materials needed:

1. Metal: 1 piece 22 gauge (.031) approximately 9" x 14".
   1 piece 22 gauge (.031) approximately 12" x 27".
2. Rivets: size 2 lb.
3. Bar solder, half and half.

Procedures:

1. Secure patterns from layer-out (or develop patterns as directed).

2. Study specifications of job.

3. Select scrap or stock metal of required gauge.

4. Measure pattern and block out to sizes needed on square shears.

5. Transfer patterns to metal.

6. Cut out collar using straight and circular hand shears.

7. Notch pipe with straight shears.

8. Punch all rivet holes with the hand punch.

9. Deburr all edges.

10. Joggle edge as noted on Pattern Layout. See Reference P.

11. Form brakes.
    Note: Make brakes in order shown on Pattern Layout.

12. Double seam pipe together.

13. Fold edge of collar.

14. Roll collar on slip roll.

15. Mark off flange on collar.

16. Groove the seam of the collar.

17. Start flange on turning machine.

18. Finish flange with peening edge of riveting hammer.
    Note: The complete inside surface area of the flange must be in contact with the pipe.

19. Notch part (if necessary) of pipe that will be flanged back against the collar.

20. Layout and punch rivet holes in flange of collar.

21. Set collar in position and transfer hole layout to pipe.

22. Cut out hole in pipe with shears.

23. Center punch holes laid out.

24. Punch these holes with a 5/32" diameter punch.
    Note: If you cannot reach all of the holes with the hand punch, drill those which cannot be reached.

25. Rivet collar on to pipe.

26. Hammer "hole flange" of pipe tightly around collar.

27. Check all dimensions and dress up.

28. Solder fume-tight.

29. Rinse off all remains of flux with water and wipe dry with waste.

References:

1. Reference P - "How to Make a Joggle on a Cornice Brake".

Questions:

1. Refer to step No. 24. What would the rivet hole diameter have been if 12 gauge metal had been used on this job?
2. Why must the brakes be made in the order shown on the Pattern Layout?
3. What is the procedure for joggling the edge of pipe?
4. Explain the "note" under procedure No. 24.

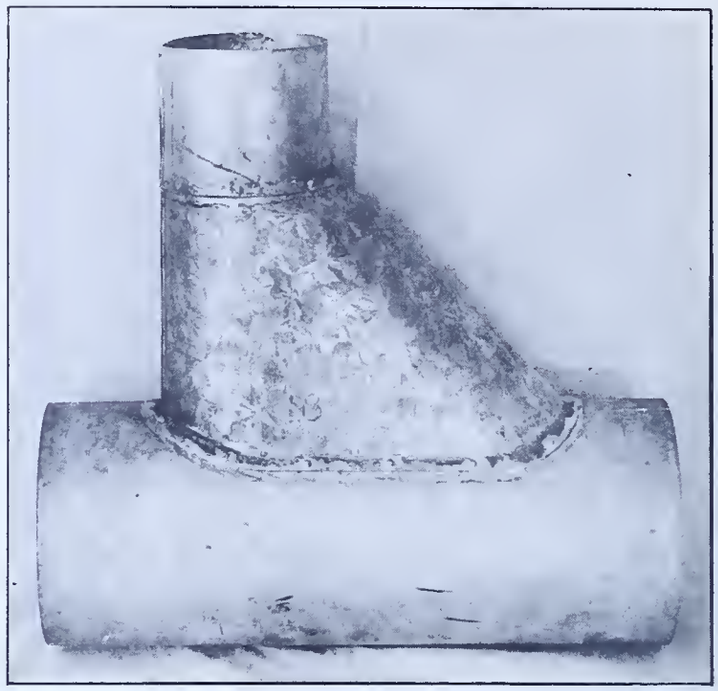
FABRICATE A 45° SHOE COLLAR, DIAMETERS UNEQUAL

Objectives:

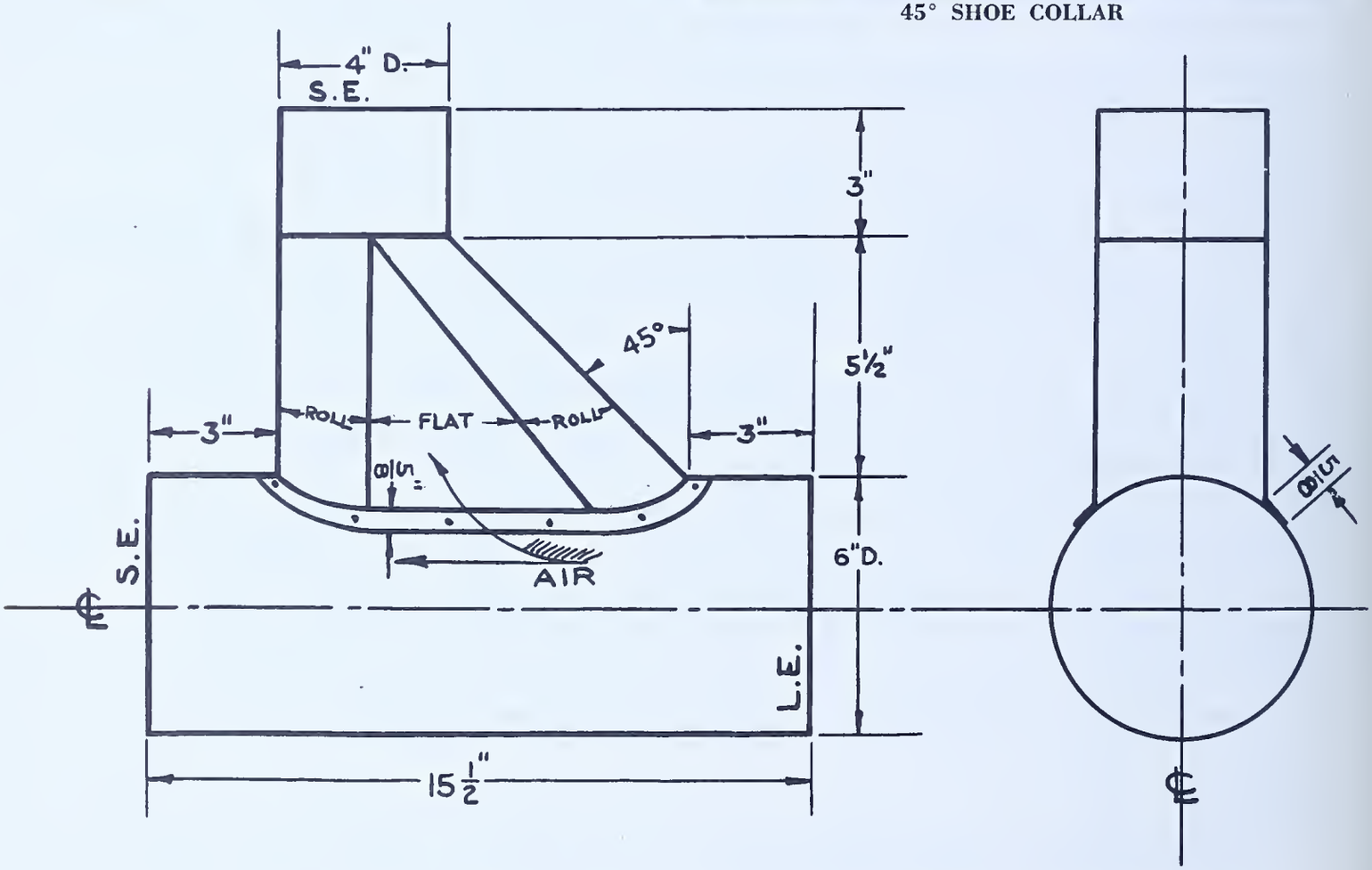
1. Learn how to lay out and fabricate a 45° shoe collar, diameters unequal.
2. How to use burring machine to turn a single edge.
3. How to assemble shoe and collar, and peen seam.

General Information:

The shoe collar is sometimes used where confined areas prevent the use of an angle collar. The "shoe" part of the collar is shaped to decrease the air friction at outlet.



45° SHOE COLLAR



JOB 18. - 45° SHOE COLLAR - DIFFERENT DIAMETERS

Specifications:

1. Dimensions: 4" diameter 45° shoe collar on 6" diameter pipe.
2. Seams: riveted and soldered.
3. Laid out with small end.
4. Rivet spacing for joints approximately 2" ℄ - ℄.
5. Rivet spacing for seams approximately 2".
6. Metal: galvanized sheet steel.
7. Collar to be peened to reducer.
8. Standard lap allowance.

Tools needed:

1. Scriber
2. Center punch
3. Square
4. Riveting hammer
5. Mallet
6. Rivet set (No. 5)
7. Hand punch (No. 5)
8. Soldering coppers
9. Straight hand shear
10. Aviation hand shear
11. Groover No. 0
12. Tape rule
13. Setting-down hammer

Equipment needed:

1. Square shear
2. Brake
3. Slip roll
4. Beakhorn stake
5. Gas furnace
6. Hollow mandrel
7. Turning machine
8. Square head stake
9. Burring machine

Materials needed:

1. Metal: Pipe: 1 piece 20 gauge (.038) 16" x 20".
   Shoe, 2 pieces 24 gauge (.025) 10" x 16".
   Collar for shoe, 1 piece 24 gauge (.025) 3-1/2" x 14".
2. Rivets: size 1-1/2 lb. for collar and 2-1/2 lb. for pipe.
3. Bar solder.

Procedures:

1. Secure patterns from layer-out (or develop pattern as directed).

2. Study specifications of job.

3. Select scrap or stock metal of required gauge.

4. Measure pattern and block out to sizes needed on square shear.

5. Transfer patterns to metal.

6. Cut out parts that make up collar, using straight and circular hand shears.

7. Punch all rivet holes.

8. Deburr metal.

9. Roll parts of collar and pipe to shape on the slip roll.

10. Rivet pipe.
    Note: Do not rivet end holes of pipe seam. These end rivets will be placed when the pipe is joined with another pipe or shape.

11. Rivet collar parts together.

12. Turn single edge on shoe collar. See Fig. 1.

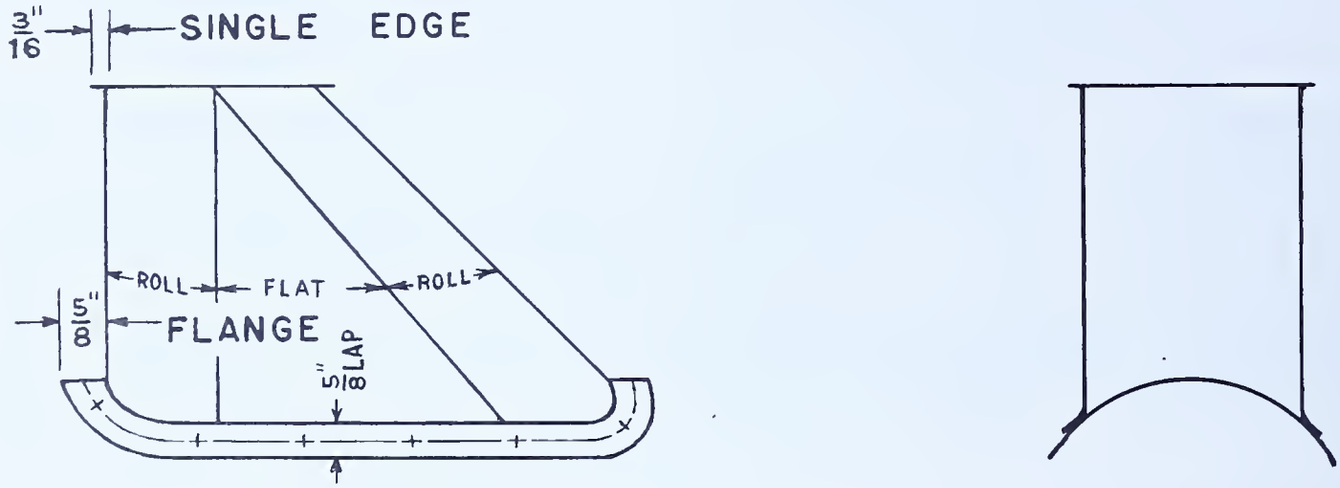


FIG. 1 — SHOE COLLAR

13. Flange shoe to fit pipe. See Fig. 1.

14. Turn double edge on collar which is to be peened to shoe. See Fig. 2.

15. Assemble shoe and collar and peen seam as in Fig. 3.

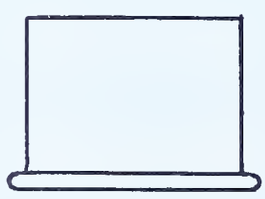


FIG. 2 — COLLAR WITH DOUBLE EDGE

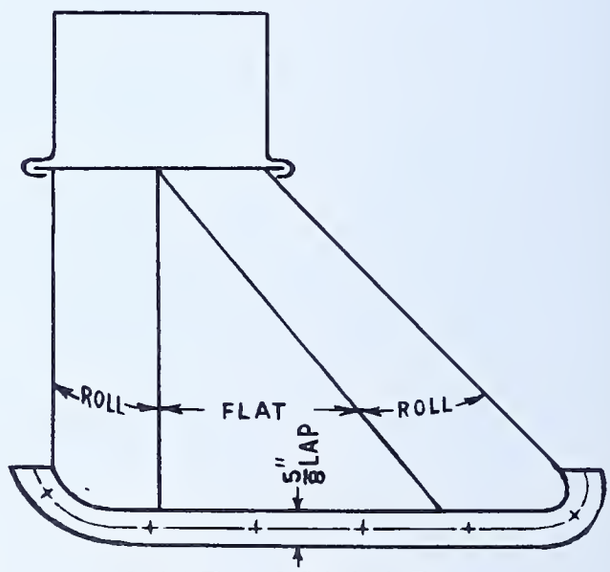


FIG. 3 — SHOE COLLAR ASSEMBLED

16. Start flange on collar using turning machine.

17. Stretch collar flange to suit pipe.

18. Layout and punch rivet holes in collar flange.

19. Place collar in position on pipe and mark collar opening and rivet holes.

20. Mark allowance for "knockover" where throat of collar joins pipe.

21. Clean out the opening for collar.

22. Notch throat for "knockover".

23. Center punch mark rivet holes.

24. Punch rivet holes with hand punch.

25. Deburr edges.

26. Rivet collar and pipe together.

27. Turn "knockover" lip in throat of collar.

28. Dress pipe and collar closer using dolly bar and hammer.

29. Solder fume-tight.

30. Rinse off all remains of flux with water and wipe dry with waste.

Reference:

1. See References for Job 18.
2. Reference " - "Closing a Peened Edge".

Questions:

1. What size rivet would have been specified if the pipe were made from 16 gauge and the collar from 20 gauge?
2. In the above steps the rivet holes were punched in the flange of the shoe collar and then located, and punched in the pipe. Why were the holes not laid out and punched in the pipe first, and then transferred to the collar?

FABRICATE A CENTRAL REDUCER

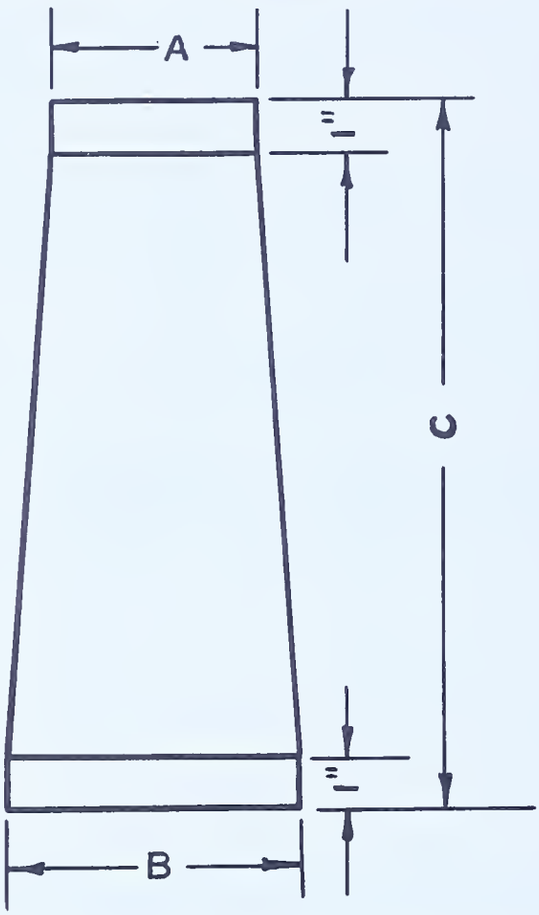
Objectives:

1. To learn how to fabricate a central reducer.
2. To learn how to make a N.W.T. intermediate flange.

General Information:

Reducers are used to connect ducts having different diameters. If the center lines of the ducts to be connected are in alignment with a connecting fixture, it is called a central-reducer. If the center lines are paralled but do not align or coincide with the connecting fixture, it is called an off-center reducer.

The pattern for a central reducer is laid out by the radial line development method, and the pattern for an off-center reducer is laid out by the triangulation method.



JOB 19a, 19b CENTRAL REDUCER RND. TO RND.

DIMENSIONS

	A	B	C
19a	4"	$5\frac{1}{2}$"	$13\frac{1}{4}$"
19b	4"	6"	12-5/8"

CENTRAL REDUCER

Specifications:

1. Dimensions: 5-1/2" diameter to 4" diameter for Job No. 19a
   6" diameter to 4" diameter for Job No. 19b
2. Seams: Grooved and soldered.
3. To be laid out with small end as per schedule.
4. Rivet spacing for joint to be approximately 2" ℄ - ℄
5. Metal: 22 gauge (.031) galvanized sheet steel.
6. 1" straight allowed on each end of reducer to be dressed to suit air flow.
7. If practice shop assembly desired, a 6" Flange needed for Job 19b.

Tools needed:

1. Setting-down hammer
2. Scriber
3. Center punch
4. Square
5. Dividers
6. Riveting hammer
7. Mallet
8. Hand punch (No.5)
9. Metal gauge
10. Soldering coppers (2)
11. Rule
12. Straight hand shear
13. Curved hand shear
14. Groover (No.2)

Equipment needed:

1. Square shear
2. Bar folder or brake
3. Slip roll
4. Hollow mandrel
5. Gas furnace
6. Turning machine

Materials needed:

1. Metal: Job No. 19a - one piece 22 gauge (.031) approximately 14" x 20".
   Job No. 19b - one piece 22 gauge (.031) approximately 16" x 20".
2. Bar solder

Procedures:

1. Secure pattern from layer-out (or develop pattern as directed).
2. Study specifications of job.
3. Select scrap or stock metal of required gauge.
4. Measure pattern and blockout metal on square shear.
5. Transfer pattern to metal.
6. Cut out reducer using straight and curved hand shears.
7. Deburr edges.
8. Fold edges to be grooved on brake or bar folder.
9. Form reducer to correct shape using slip roll.
10. Groove seams on a hollow mandrel stake.
11. Stretch 1" straight on small end of reducer to required size.
12. Shrink large end of reducer to required size.
13. Place flange on large end of 19b.

Questions:

1. What is the purpose of a reducer?
2. How would you check the gauge of metal?
3. Which end of vent is notched?

FABRICATE AN OFF-CENTER REDUCER ROUND TO ROUND

Objective:

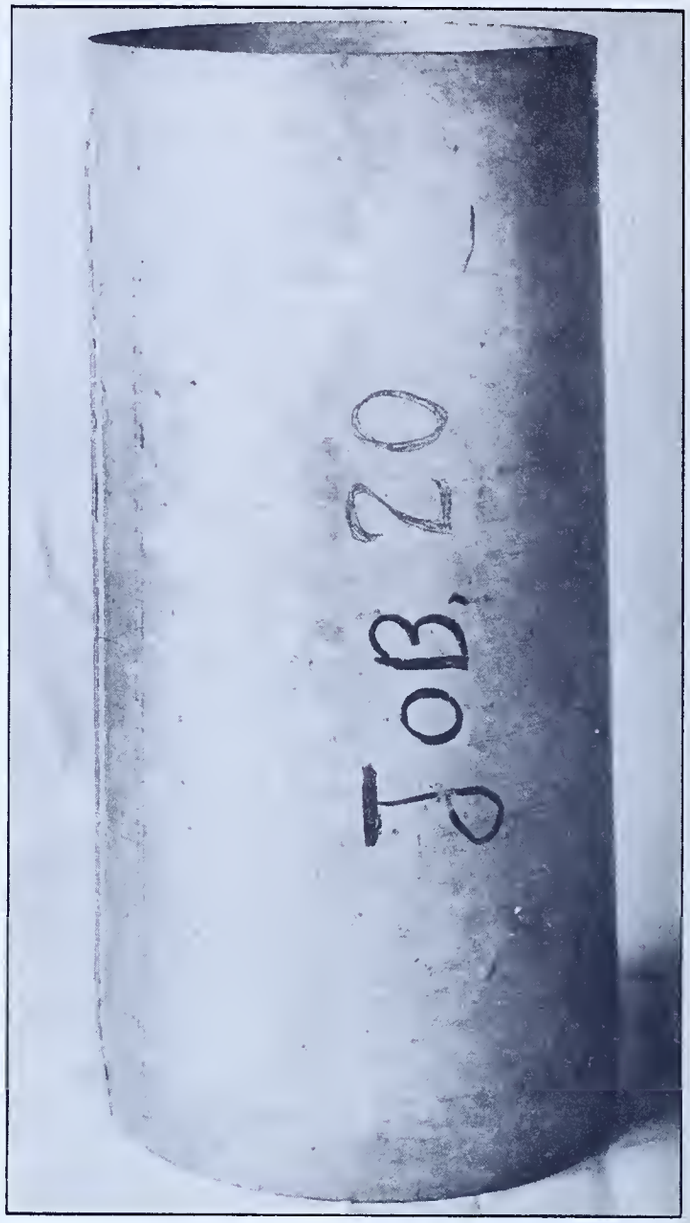
1. To learn how to fabricate an off-center reducer round to round.

General Information:

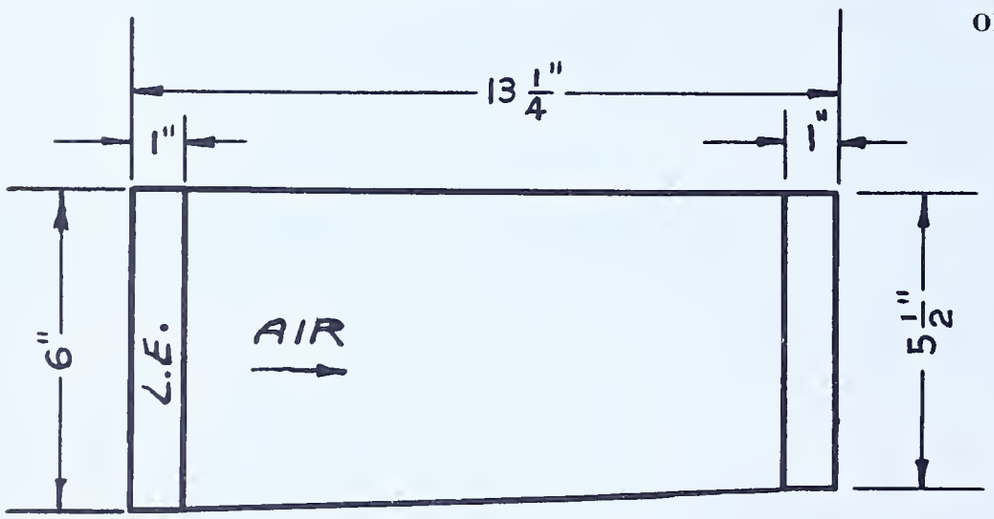
The off-center reducers are used more frequently in marine sheet metal work than the central reducers. In fabricating either the off-center or central reducer, similar procedures are involved except in laying out an off-center reducer the triangulation method is used.

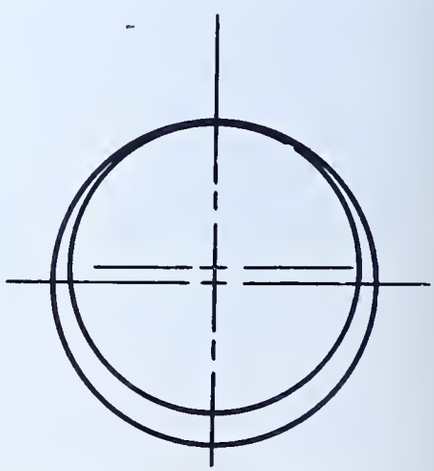
Specifications:

1. Dimensions: 6" diameter to 5-1/2" diameter.
2. Seams: Riveted and soldered.
3. Rivet spacing for joint to be approximately 2" ℄ - ℄.
4. Rivet spacing for seam to be approximately 2".
5. To be laid out with a small end.
6. Metal: 22 gauge (.031) galvanized sheet steel.



OFF CENTER REDUCER





JOB 20 OFF CENTER REDUCER-ROUND TO ROUND

Tools needed:

1. Scriber
2. Center punch
3. Dividers
4. Square
5. Riveting hammer
6. Mallet
7. Rivet set (No.5)
8. Setting down hammer
9. Hand punch (No.5)
10. Metal gauge
11. Soldering coppers
12. Rule
13. Straight hand shear
14. Curved hand shear

Equipment needed:

1. Square shear
2. Slip roll
3. Hollow mandrel
4. Gas furnace
5. Turning machine

Materials needed:

1. Metal: 1 piece 22 gauge (.031) approximately 16" x 20".

Procedures:

1. Secure pattern from layer-out (or develop pattern as directed).
2. Study specifications of job.
3. Select scrap or stock metal of required size and gauge.
4. Measure pattern and blockout on square shears.
5. Transfer pattern to metal.
6. Cut out reducer using straight and curved hand shears.
7. Deburr edges.
8. Form reducer diameter using slip roll.
9. Rivet or groove reducer together.
10. Stretch small end to suit pipe.
11. Shrink large end to suit pipe.
12. Solder all seams.
13. Rinse with water and dry with waste.
14. Solder complete assembly so that it may be made fume-tight.
15. Rinse with water to remove remains of flux and wipe dry with waste.

Questions:

1. Why is a reducer used in a run of duct?
2. What metal allowance is made for small end?
3. When the seam of this off-center reducer is wanted in a desired location care must be taken when rolling on slip roll. Why?
4. Why is a reducer made off center?

FABRICATE A 30° COLLAR ON A REDUCER

Objectives:

1. To learn how to fabricate a 30° collar on a reducer.
2. To learn how to make a N.W.T. Intermediate Flange.
3. To learn how to use a Beverly Throatless Shear.

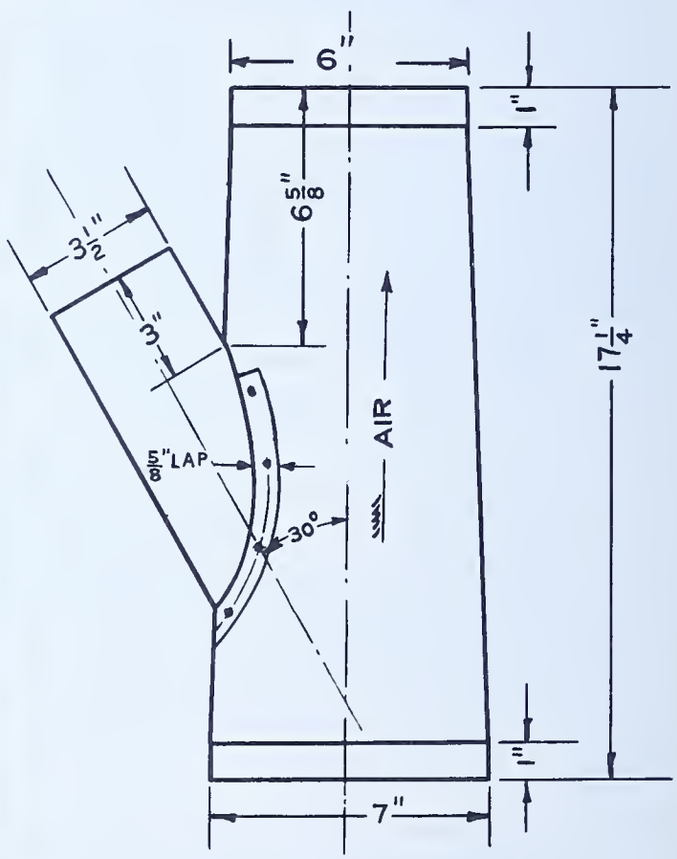
General Information:

The collar is used to connect branch trunks to the main trunks. It is fabricated and installed so that the seams are hidden beneath the deck or against the bulkhead. The parallel line development method is used for laying out pattern for the collar and radial line development is used for laying out the pattern for the reducer.

Specifications:

1. Dimensions: 3-1/2" diameter collar on a 7" diameter to 6" diameter reducer. Flange on large end.
2. Seams: riveted and soldered.
3. Rivet spacing for joints approximately 2" ℄ - ℄
4. Rivet spacing for seams approximately 2".
5. Metal: 18 gauge (.050) and 20 gauge (.038) galvanized sheet steel.
6. Standard lap allowance.

30° COLLAR ON A REDUCER



JOB 21

30° COLLAR ON REDUCER - CENTRAL

Tools needed:

1. Scriber
2. Center punch
3. Square
4. Dividers
5. Riveting hammer
6. Mallet
7. Rivet set (No. 4)
7. Hand punch (No. 5)
9. Metal gauge
10. Soldering coppers
11. Rule
12. Center punch
13. Drift pin
14. Screw driver
15. Aviation shears

Equipment needed:

1. Square shear
2. Slip roll
3. Stakes, hollow mandrel and beak horn
4. Gas furnace
5. Bench unishear, Beverly Throatless shear or band saw

Materials needed:

1. Metal: 1 piece 18 gauge (.050) approximately 20" x 24".
   1 piece 20 gauge (.038) approximately 13" x 11".
2. Rivets: size 3 lb.
3. Bar solder
4. Sheet metal screws (size 10 x 1/2 R.H.)

Procedures:

1. Secure pattern from layer-out (or develop as directed).
2. Study specifications of job.
3. Select scrap or stock metal of required gauge.
4. Measure pattern and blockout to sizes needed on square shears.
5. Transfer patterns to metal.
6. Cut out pieces for reducer and collar.
7. Punch required rivet holes for seams of collar and reducer.
8. Deburr holes.
9. Form shapes on rollers.
10. Rivet collar.
11. Rivet reducer.
12. Check shapes for size.
13. Shrink large end of reducer.
14. Stretch small end of reducer.
15. Stretch required flange on collar.
16. Punch rivet holes in flange of collar.

17. Place collar in position on reducer and mark collar opening and rivet holes.

18. Mark allowance for "knockover" where throat of collar joins reducer.

19. Cut out the opening for collar.

20. Notch throat for "knockover".

21. Center punch mark rivet holes.

22. Punch rivet holes with hand punch.

23. Deburr edges.

24. Rivet collar and reducer together.

25. Turn "knockover" lip in throat of collar.

26. Dress pipe and collar closer using dolly bar and hammer.

27. Solder fume-tight.

28. Rinse off all remains of flux with water and wipe dry with waste.

Questions:

1. Explain how the circumference diameters are calculated.
2. How did you determine the spacing for the rivet holes?
3. Why is a collar used?
4. What are the methods of securing collar to trunk?

FABRICATE AN OFF-CENTER RECTANGULAR REDUCER

Objectives:

1. To learn how to fabricate an off-center rectangular reducer.
2. To learn how to brake joggles.

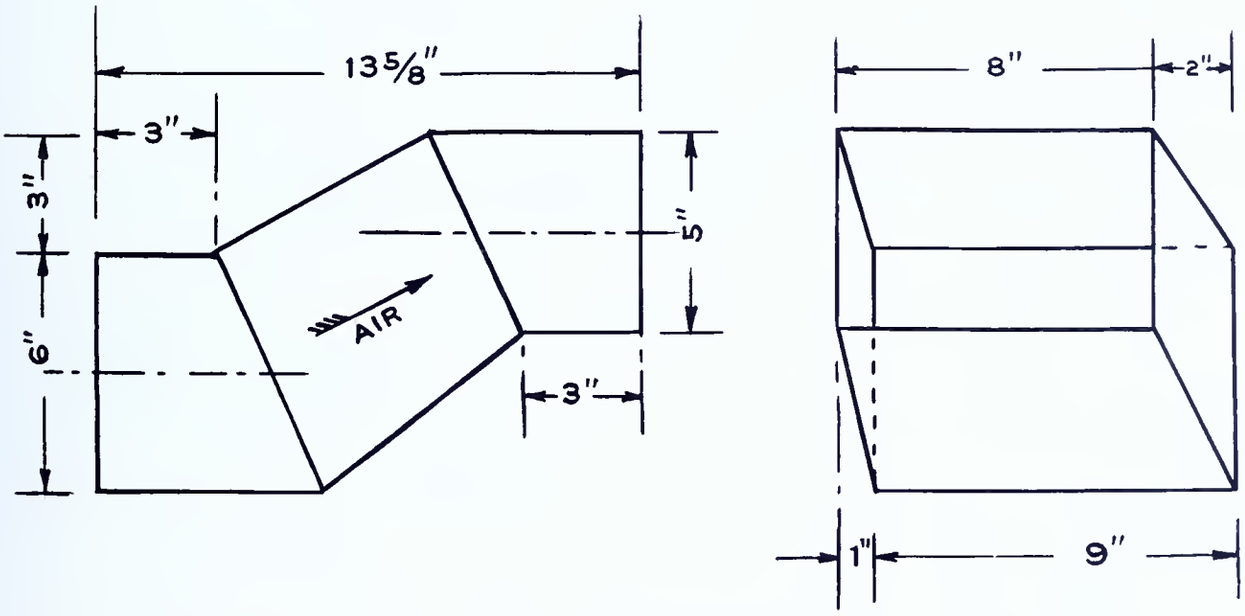
General Information:

In marine sheet metal work the off-center rectangular reducers are used more frequently than the central reducers. In fabricating either the central or off-center reducer similar procedures are involved in laying out a pattern--the triangulation method is used.

Specifications:

1. Dimensions: 6" x 9" to 5" x 8".
2. Seam and joints riveted.
3. Rivet spacing for joint approximately 2" ℄ - ℄
4. Rivet spacing for seam approximately 2".
5. Metal: 18 gauge (.050) black sheet metal.

OFF-CENTER RECTANGULAR REDUCER



JOB 22 — OFF CENTER RECT. REDUCER

Tools needed:

1. Soapstone
2. Center punch
3. Square
4. Dividers
5. Riveting hammer
6. Rivet set (No. 3)
7. Hand punch (No. 2)
8. Metal gauge
9. Rule
10. Drift pin

Equipment needed:

1. Lever shear
2. Brake
3. Stakes
4. Bench Unishear, heavy duty lever slitting shear

Materials needed:

1. Metal: One piece 18 gauge (.050) approximately 7" x 31"
   One piece 18 gauge (.050) approximately $6\frac{1}{4}$" x 27"
   One piece 18 gauge (.050) approximately 12" x 32"
2. Rivets, size 4 lb.

Procedures:

1. Secure pattern from layer-out (or develop pattern as directed).
2. Study specifications of job.
3. Select scrap or stock metal of required size and gauge.
4. Measure pattern and blockout to sizes needed on lever shear.
5. Transfer pattern to metal.
6. Cut out body of reducer and notch collars on lever shear.
7. Punch all holes.
8. Deburr completely.
9. Brake small and large end collars.
10. Brake flange of reducer to receive small end collar.
11. Brake reducer.
12. Rivet seams of collars and reducer.
13. Rivet collars to reducer.
14. Solder.
15. Clean.

FABRICATE A DOUBLE-SEAMED RECTANGULAR ELBOW

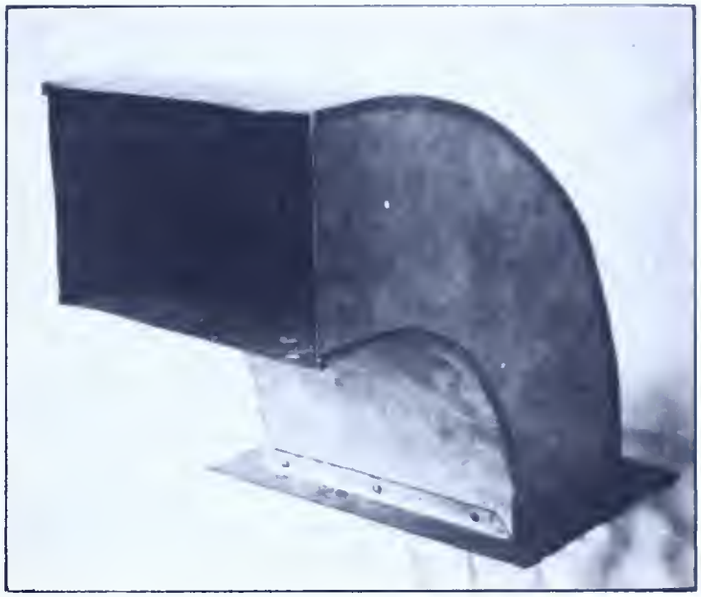
Objective:

1. To learn how to fabricate a double-seamed rectangular elbow.

General Information:

Double seaming is used in making small N.W.T. rectangular shapes. Seams must be placed on the corners. The allowances for double seaming are standard.

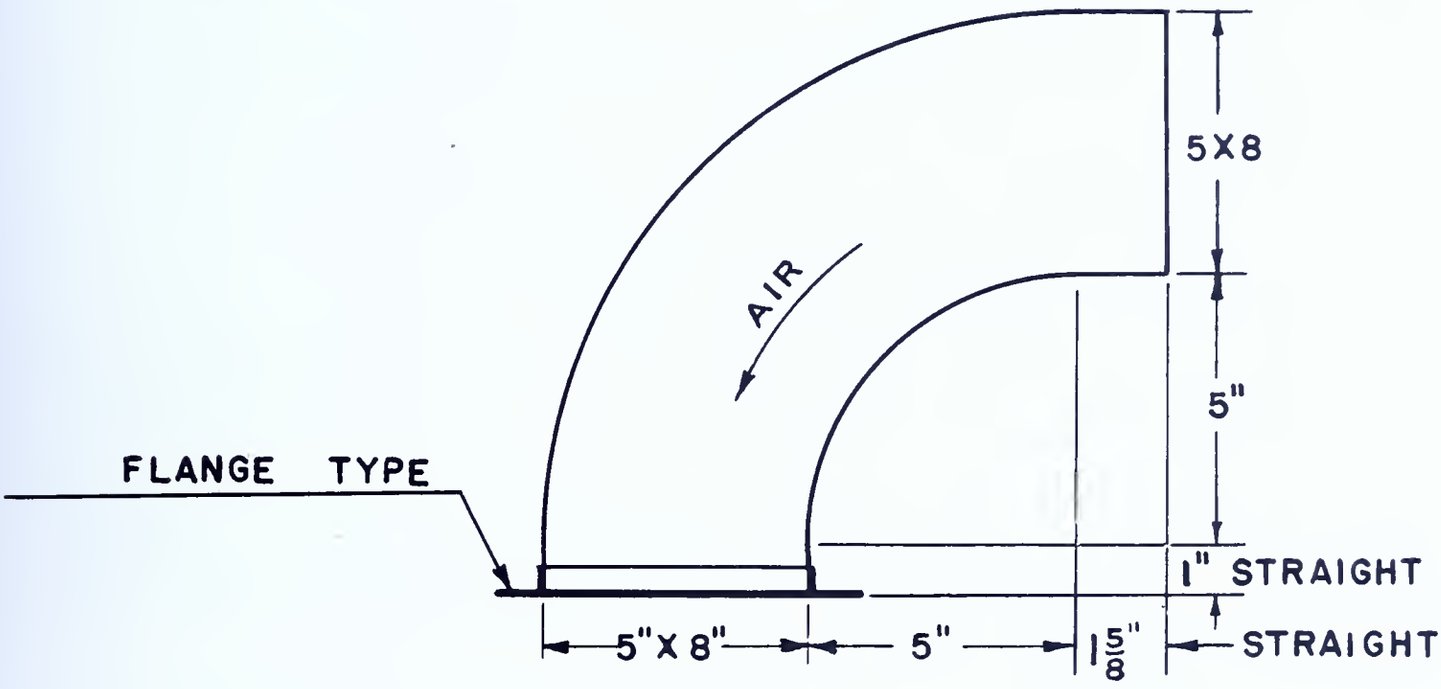
In marine sheet metal work elbows are divided into two classes; elbows in mains and elbows in branches. The main may be defined as one duct from which smaller ducts are taken. The branch is a pipe or duct that diverges from the main duct.



DOUBLE-SEAMED RECTANGULAR ELBOW

Specifications:

1. Dimensions: 90° 5" x 8" elbow.
2. Double seamed.
3. Soldered
4. Metal: 24 gauge (.025) galvanized sheet steel.



JOB 23 — 90° RECTANGULAR ELBOW

Tools Needed:

1. Scriber
2. Trammel points and beam
3. Center punch
4. Square
5. Riveting hammer
6. Pliers
7. Dolly
8. Mallet
9. Hand punch (No. 5)
10. Metal gauge
11. Soldering coppers
12. Rule
13. Straight shears
14. Aviation shears

Equipment needed:

1. Square shear
2. Brake
3. Slip roll
4. Double seaming stake
5. Gas furnace
6. Rotary circular machine
7. Turning machine
8. Scroll shear

Materials needed:

1. Metal: Two pieces 24 gauge (.025) approximately 12" x 12" for cheeks.
   One piece 24 gauge (.025) approximately 10" x 19" for heel.
   One piece 24 gauge (.025) approximately 10" x 11" for throat.
2. Bar solder.

Procedure:

1. Secure pattern from layer-out (or develop as directed).
2. Study specifications of job.
3. Select scrap or stock metal of required gauge.
4. Measure pattern and blockout metal on square shears.
5. Transfer pattern to metal.
6. Cut out cheeks and notch heel and throat using straight and lever shears.
7. Deburr all edges.
8. Turn edges of cheeks using the turning machine.
9. Dress edges of cheeks using hammer and dolly.
10. Shape heel and throat about 100° using slip roll. (A trifle more than a right angle).
11. Force rolled heel and throat in brake and bend edges.
    Note: When these edges are bent, heel and throat will have a rolled effect. If the heel and throat cannot be rolled by hand over a mandrel to shape, insert pieces of scrap metal in folded edges and then roll to correct shape in slip roll.
12. Double seam cheeks to heel, using a double seaming stake or rail.
    Note: The heel must be double seamed to cheeks before seaming to throat.

13. Dress up elbow, using dolly, mallet, and hammer.

14. Secure specified flange or fabricate one.

15. Layout and punch rivet holes

16. Rivet flange to elbow.

17. Solder fume-tight.

18. Rinse with water and wipe dry with waste.

References:

1. See References for Job 23.

2. Job No. 4 - "How to Fabricate a N.W.T. to W.T. Flange".

3. Reference G - "Double Seaming".

Questions:

1. Why must the heel be double seamed to the cheeks before the throat?
2. What is the heaviest gauge metal double seamed?
3. Why is heel and throat shaped on slip rolls before edges are formed on brake?
4. Why are heel and throat rolled to shape before edges are bent on brake?

FABRICATE A ROUND PEENED ELBOW

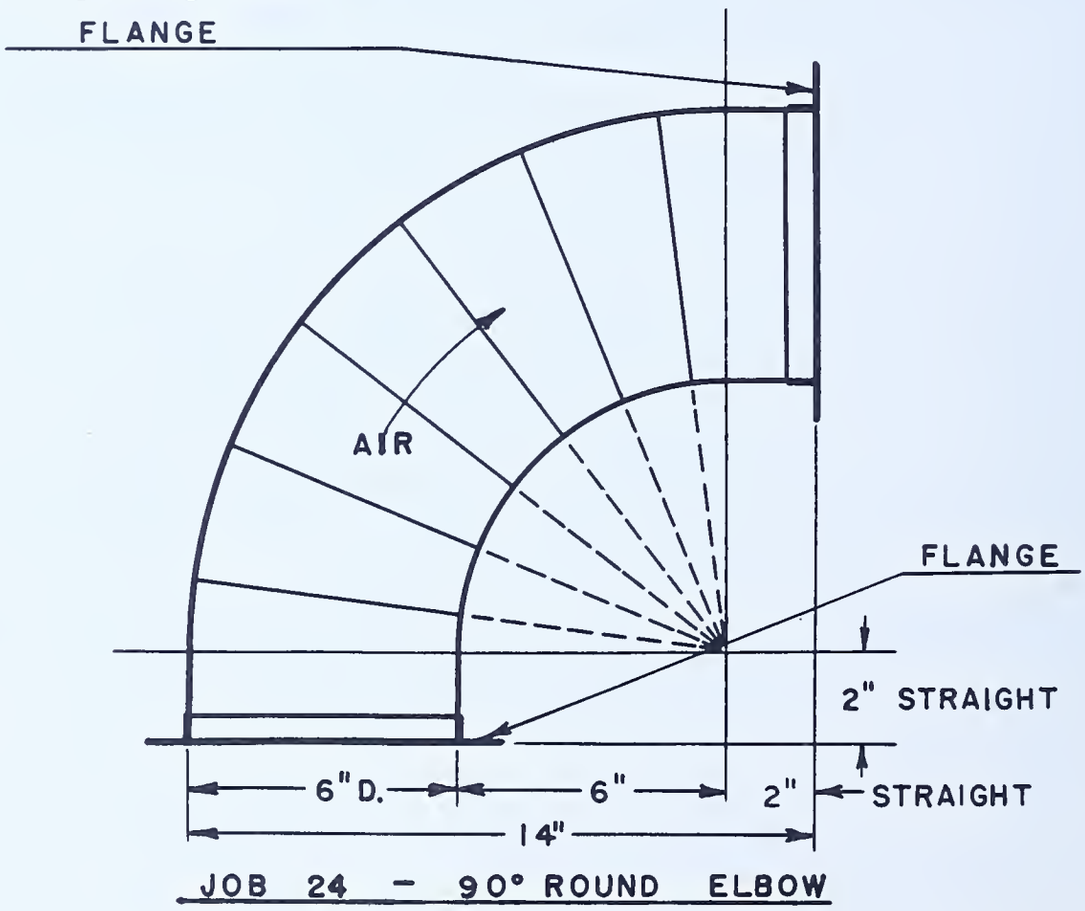
Objectives:

1. To learn how to fabricate a 90° round peened elbow.
2. To learn how to slip roll pieces of elbow so that the seam will come in desired location.

General Information:

When a run of pipe or duct makes a turn, the fitting used to accomplish this turn is called an elbow. Most sheet metal elbows consist of a number of mitered pieces of straight pipe joined together by means of either peening, riveting or welding. If the latter is used, either arc, gas or spot welding may be specified. In marine sheet metal work elbows are made with a large throat radius and consist of seven or more sections. In shop practice the radius of an elbow equals the diameter unless otherwise specified. In peening sections together care must be taken not to mark elbow with peening hammer.

ROUND PEENED ELBOW



JOB 24 - 90° ROUND ELBOW

Specifications:

1. Dimensions: 6" diameter, 6" throat radius.
2. Seams: riveted.
3. Joints: peened.
4. Metal: 22 gauge (.031) galvanized sheet steel.

Tools needed:

1. Scriber
2. Center punch
3. Riveting hammer
4. Rule
5. Metal gauge
6. Combination square
7. Straight shears
8. Circular or aviation shears
9. File (for deburring)
10. Mallet
11. Rivet set (No. 5)
12. Hand punch (No. 5)
13. Soldering coppers
14. Setting down hammer

Equipment needed:

1. Square shear
2. Scroll shear or Unishear
3. Slip roll (bench machine)
4. Hollow mandrel
5. Gas furnace
6. Flanging fixture
7. Turning machine

Materials needed:

1. Metal: 22 gauge (.031) galvanized sheet steel approximately 22" x 22".
2. Tinners' rivets, size 2 lb.

Procedure:

1. Secure pattern from layer-out (or develop pattern as directed).

2. Study specifications of job.

3. Select scrap or stock metal of required gauge.

4. Block out required size of stock on square shears.

5. Scribe off required pieces from pattern.

6. Cut each piece to lines, using straight, scroll, rotary shears or Unishear.

7. Deburr edges.

8. Roll pieces to correct diameter on slip rolls.

9. Rivet seams together on a cylindrical stake or hollow mandrel.
   Note: Arrange laps so that the seams will all be uniform when the pieces of the elbow are peened together.

10. Turn edges on a turning machine, in preparation for peening.

11. Assemble and peen edges together.
    Note: Turn all double edges then small edges. Use hatchet stake to seam edges in throat.

12. Check for 90° angle.

13. Solder fume-tight.

14. Rinse off all remains of soldering flux with water and wipe dry.

Reference:

1. Job 4---"How to Fabricate a N.W.T. to a W.T. Flange".

Questions:

1. What assembly advantages does an elbow cut from a fish tail pattern have over one cut from other patterns?

2. Would more or less metal be used if the specifications called for the seam to be placed along the center of the heel? Why?

3. How many full pattern pieces in a 7 piece elbow?

FABRICATE A FLAT OVAL ELBOW

Objectives:

1. To learn how to fabricate a flat oval elbow.
2. To learn how to arrange laps so that all seams will be uniform.

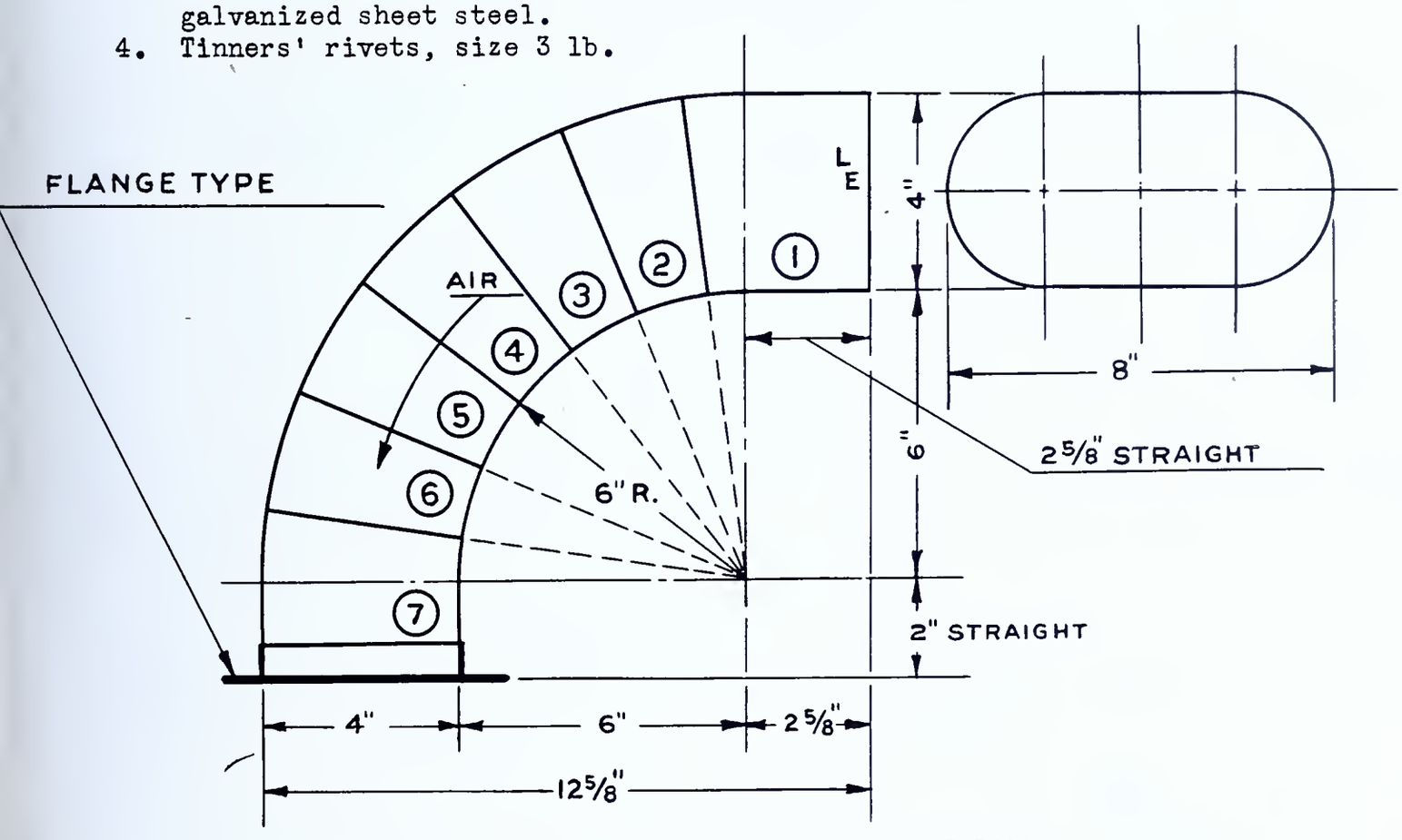
General Information:

Flat oval design is used when space does not permit the use of round work. The parallel line method of development applies to laying out both round and flat oval elbows.

Specifications:

1. Dimensions: 4" x 8" flat oval, 6" throat radius.
2. Seams and joints riveted.
3. Metal: 20 gauge (.038) galvanized sheet steel.
4. Tinners' rivets, size 3 lb.

FLAT OVAL ELBOW



JOB 25-FLAT OVAL ELBOW

Tools needed:

1. Metal gauge
2. Scriber
3. Dividers
4. Rule
5. Combination square
6. File (for deburring)
7. Mallet
8. Rivet set, (No. 4)
9. Hand punch, (No. 5)
10. Center punch
11. Soldering coppers

Equipment needed:

1. Square shear
2. "Unishear" or scroll shear
3. Slip roll
4. Cornice brake
5. Hollow mandrel
6. Square head stake
7. Turning machine
8. Spot welding equipment
9. Flanging fixture
10. Gas furnace

Materials needed:

1. Galvanized sheet steel, 20 gauge (.038), one piece approximately 24" x 20".
2. Galvanized sheet steel, 16 gauge (.062), one piece approximately 7" x 11".
3. Tinners' rivets, size 3 lb.
4. Solder, half and half.

Procedures:

1. Secure pattern from layer-out (or develop pattern as directed).

2. Study specifications of job.

3. Select scrap or stock metal of required gauge and size.

4. Determine from pattern the size of material needed, and block out on the square shear.

5. Scribe off required pieces from pattern.

6. Cut out and notch pieces using a scroll, rotary shear or "Unishear".

7. Space rivet holes 2" apart on centers.

8. Punch all rivet holes.

9. Deburr holes and edges.

10. Roll pieces to correct diameter in slip rolls.

11. Rivet seams together on a cylindrical stake or hollow mandrel.
    Note: Arrange laps so that the seams will all be uniform when the pieces of the elbow are peened together.

12. Shrink flange of mitered end of large end (Piece "1").

13. Shrink and stretch flanges of intermediate pieces.

14. Stretch flange of mitered end of small end (Piece "7").

15. Rivet the large end to one of the intermediate pieces.

16. Rivet the remaining intermediate pieces.

17. Rivet small end in place.

18. Dress up flanges between rivets so that they fit tightly against each other.
Note: Large end is always used to receive flanges.

19. Make up flange and rivet to end.

20. Solder all seams and rivets fume-tight.

21. Rinse off all remains of soldering flux with water, and wipe dry with waste.

Questions:

1. Why is it necessary to use a hammer when stretching a flange?
2. Why is a mallet used to shrink a flange?
3. Draw a free hand diagram showing the scheme for stretching and shrinking the riveted miter flanges of an elbow.
4. Which stake is to be used for riveting?
5. Why is metal to be dressed between rivets?

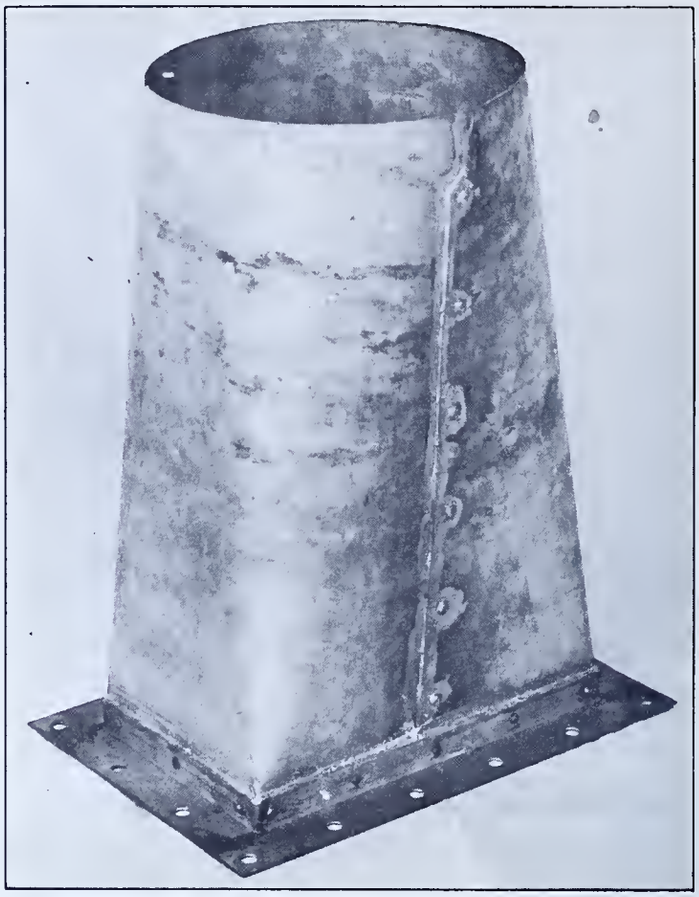
FABRICATE A CENTRAL RECTANGULAR TO ROUND TRANSFORMER

Objectives:

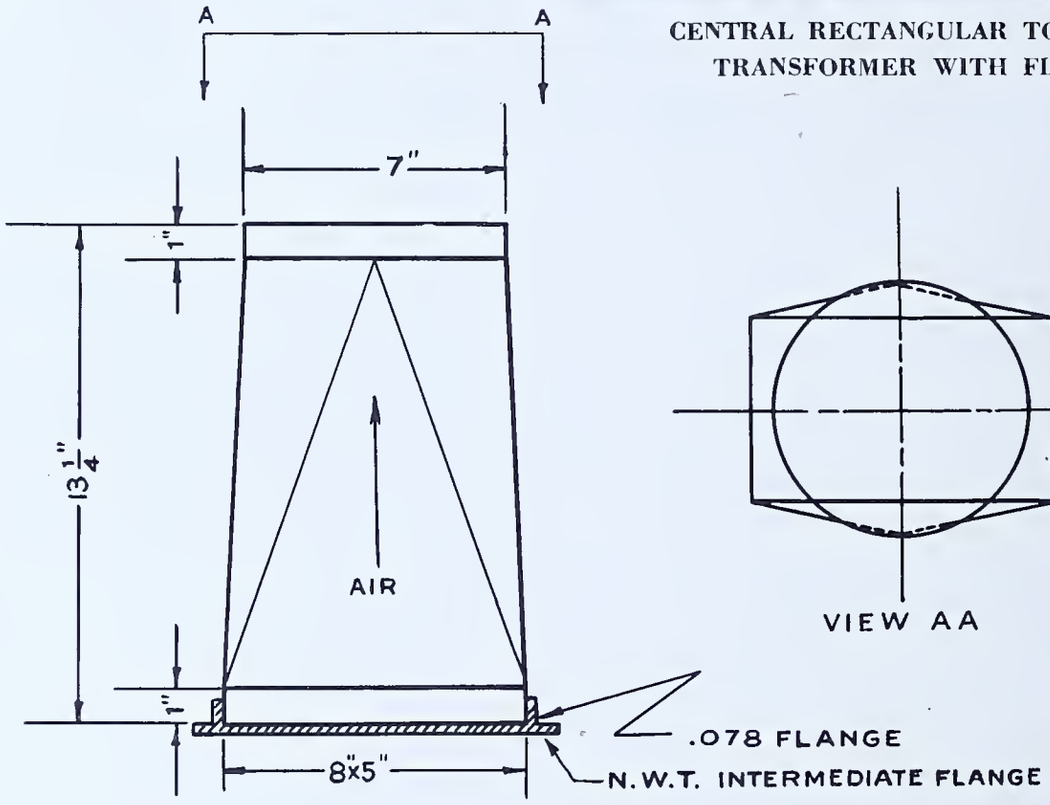
1. To learn how to fabricate a rectangular to round transformer.
2. To learn how to form the "body" of a transformer on the brake..

General Information:

The ventilation "shape" made in this job is a transition "shape", usually spoken of in the shop as a "transformer". It is a "shape" that forms the connection between two pipes or ducts that are of a different design. The one referred to in this job is circular on one end and rectangular on the other. It will be used in the ventilation system to make a connection where the duct changes from a rectangular shape to a circular.



CENTRAL RECTANGULAR TO ROUND TRANSFORMER WITH FLANGE



JOB 26

RECTANGULAR TO ROUND TRANSFORMER

Specifications:

1. Dimensions: 5" x 8" rectangle to 7" diameter.
2. All seams and rivets to be soldered fume-tight.
3. Rectangular end to be a "small end".
4. Metal: Use 20 gauge (.037) galvanized sheet steel for transformer and 14 gauge (.078) for flange.
5. Rivets: 2 lb. 2" ¢ - ¢

Tools needed:

1. Tape rule
2. Scriber
3. Riveting hammer
4. Straight hand shear
5. Hand punch (#2)
6. Ten inch 1/2 round, smooth file
7. Mallet
8. Rivet sets (No. 5 and No. 3)
9. Drills
10. Hand drill
11. Center punch
12. Two foot square
13. Dividers
14. Open end adjustable wrench
15. Raising hammer
16. Soldering coppers

Equipment needed:

1. Square shear
2. Slip roll
3. Cornice or box and pan brake
4. Flanging fixture
5. Lever shear
6. Punch press
7. Drill press
8. Nibbling machine
9. Gas furnace

Materials needed:

1. Metal: One piece 20 gauge (.038) approximately 16" x 28".
   One piece 14 gauge (.078) approximately 10" x 10".
2. Tinners' rivets, sizes 3 lb. and 5 lb.
3. Solder, half and half.

Procedure:

1. Secure pattern (or develop pattern as directed).
2. Study specifications of job.
3. Select scrap or stock metal of required gauge.
4. Measure pattern and block out metal to sizes needed on square shear.
5. Transfer pattern to metal.
6. Cut out and notch body of transformer.
7. Punch rivet holes.
8. Deburr holes and edges.
9. Shape transformer in brake following the succeeding steps: See Fig. 2 or Pattern lay-out.

10. Turn metal over and place in the brake so that the area "d1s" is exposed as shown in Fig. 1.

11. Make about an 8 degree bend along line "d1", Fig. 1.

12. Release the clamping handle and allow point "1" to move out about 1/4 inch. Do not move point "d". Keep point "d" in the position shown in Fig. 1.

13. Tighten the clamping handle and make about an 8 degree bend.

14. Release the clamping handle and allow point "1" to move out another 1/4 inch. Tighten clamping handle and make about an 8 degree bend.

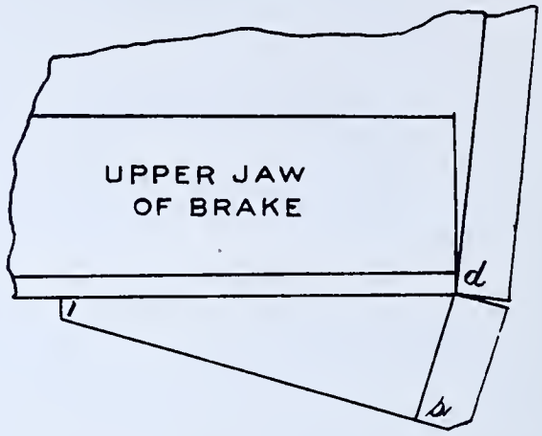


FIG. 1 – ELANK POSITIONED FOR BEND D-1

15. Repeat step 14 until you have reached line "d10" (See pattern layout, Fig. 2).

16. Release clamping handle and align point "c" and "10" with upper jaw of brake.

17. Make about an 8 degree bend along line "10-c" and proceed as in steps 11, 12, 13 and 14. When point "7" is reached, the piece will be shaped as shown in Fig. 2.

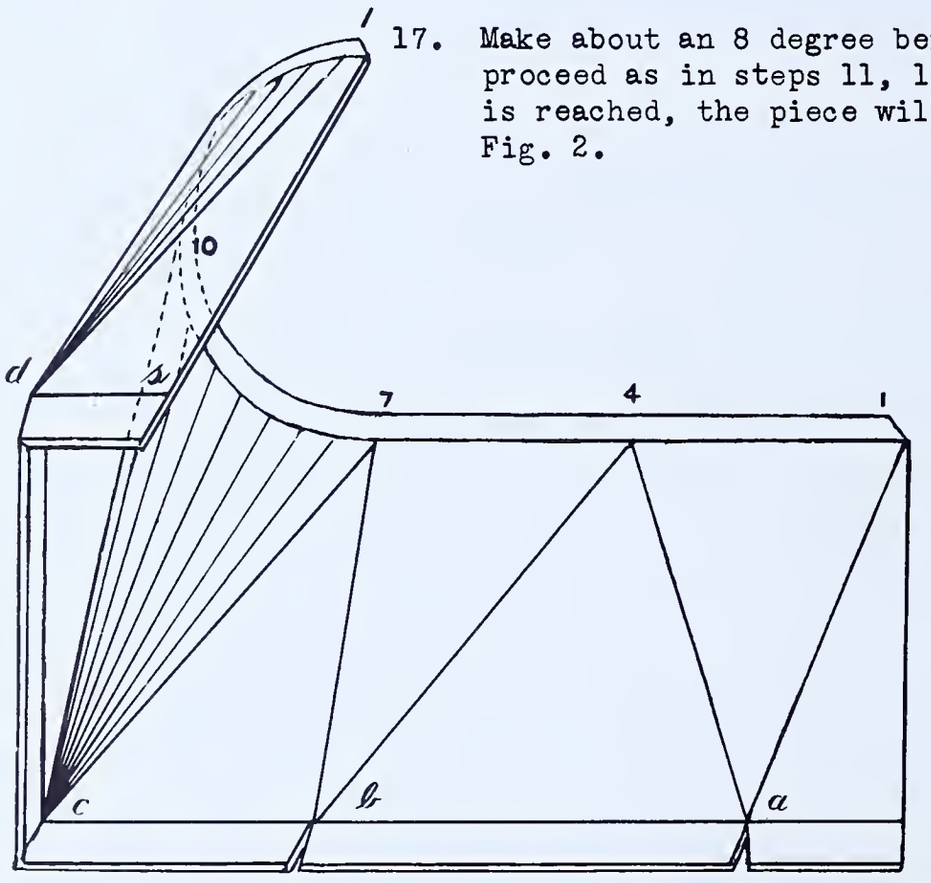


FIG. 2 – PARTLY FORMED TRANSFORMER

18. Form transformer by braking the sections 7-4 on "b", and 4-1 on "a" similar to the sections "1-10-d" and "10-7-c".

19. Dress up any imperfections in bending.

20. Rivet seam of transformer together.

21. Make a 7 inch diameter N.W.T. intermediate flange.

22. Rivet flange to transformer.

23. Solder fume-tight.
    Note: Do not solder the corners of the 1" straight part of the rectangular end. The corners of the rectangular end will be soldered when this job is assembled to Job 20.

24. Clean off all remains of flux.

References:

1. Job 8. - "Fabricate a N.W.T. Rectangular Flange".

Questions:

1. What size diameter holes are punched for $2\frac{1}{2}$ lb. rivets?
2. What size diameter holes are punched for 5 lb. rivets?
3. What is meant by the term "transformer" as used in the sheet metal trade?
4. How does a transformer differ from a reducer?

FABRICATE AN OFF-CENTER FLAT-OVAL TO ROUND TRANSFORMER

Objective:

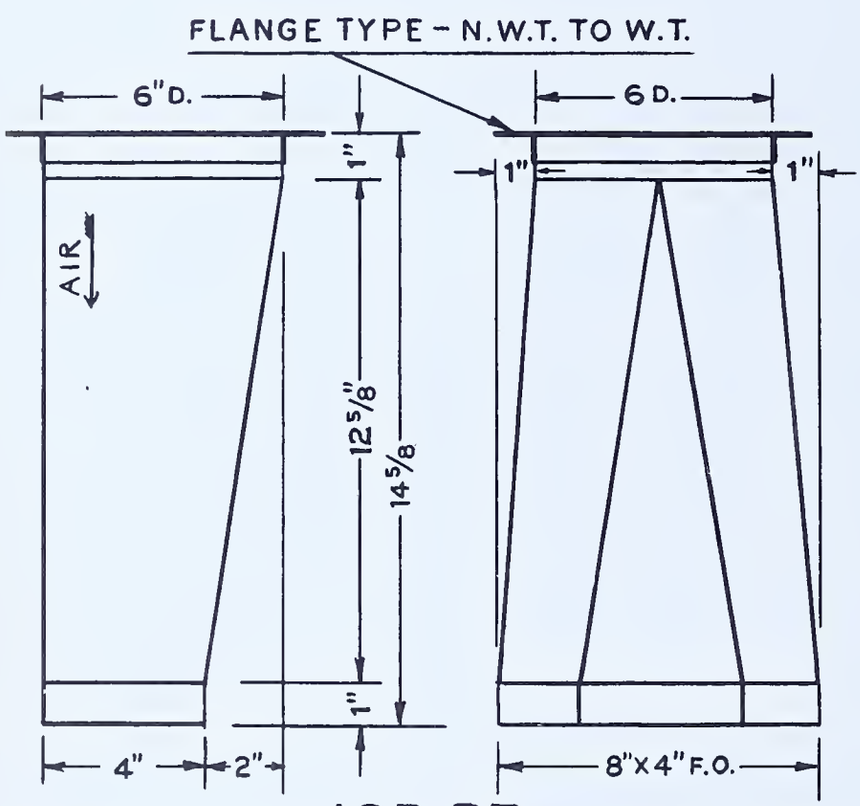
1. To learn how to fabricate a flat oval to round transformer.

General Information:

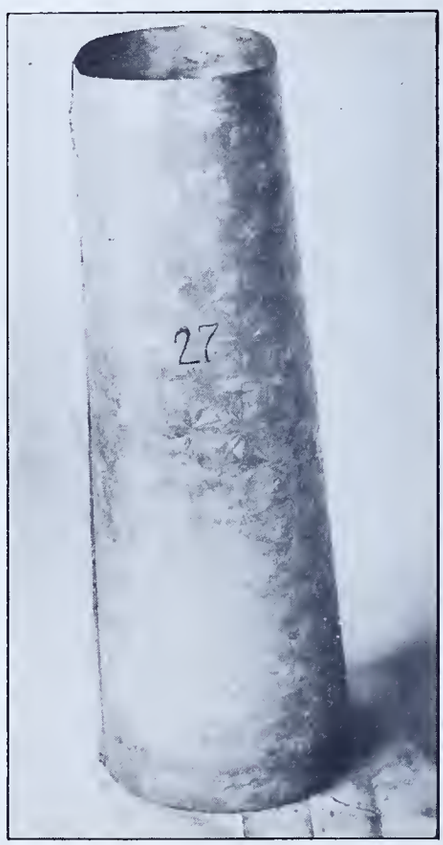
This job, like job 26, is a transition shape. It is used to form a connection between a flat oval and a round pipe.

Specifications:

1. Dimensions: 4" x 8" F.O. (Flat Oval) to 6" diameter.
2. Seams grooved.
3. Seams to be soldered fume-tight.
4. F.O. end to be a "small end".
5. Metal: 20 gauge (.038) galvanized sheet steel for transformer.
   16 gauge (.062) galvanized sheet steel for flange.
6. Circular end to be supplied with a N.W.T. to W.T. flange.



JOB 27
OFF CENTER — FLAT OVAL TO ROUND TRANSFORMER



FLAT OVAL TO ROUND TRANSFORMER

Tools needed:

1. Sheet metal gauge
2. Tape rule
3. Scriber
4. Punch
5. Riveting Hammer
6. Straight hand shears
7. 10" half-round smooth file
8. "C" clamps
9. Soldering coppers
10. Carpenters' square
11. Mallet
12. Hand Punch

Equipment needed:

1. Square shear
2. Lever shear
3. Slip roll
4. Electric spot welder
5. Stakes (as needed)

Materials needed:

1. Metal: One piece 20 gauge (.038) approximately 17" x 22"
   One piece 16 gauge (.063) approximately $12\frac{1}{2}$"x $12\frac{1}{2}$"
2. Solder, half and half, as needed.

Procedure:

1. Secure and check pattern (or develop pattern as directed).
2. Study specifications of job.
3. Select scrap or stock metal of required gauge.
4. Measure pattern and block out the 20 gauge pieces on the square shear.
5. Cut a piece 12" x 12" from 16 gauge stock on lever shear.
6. Transfer patterns to metal.
7. Cut out and notch body of transformer.
8. Deburr edges.
9. Form edges for grooving.
10. Roll body of transformer to required shape in the slip roll.
11. Groove seams of transformer.
12. Shape to required dimensions.
13. Stretch the lap allowance on the circular end of the transformer to fit a 6" circular template.
14. Shrink the lap allowance on the F.O. end of the transformer to fit 8" x 4" F.O. template.
15. Solder all seams fume-tight and clean off all remains of flux.
16. Make a 6" N.W.T. to W.T. flange.

Reference:

1. Job No. 4 - "Fabricate a N.W.T. to W.T. Flange".

Questions:

1. What does F. O. mean?
2. Explain the difference between a seam and a joint.
3. What is the decimal equivalent for 16 gauge?
4. What is the lap dimension of the seams?
5. What is the lap dimension of the joints?

FABRICATE AN OFF-CENTER FLAT OVAL TO RECTANGULAR TRANSFORMER

Objective:

1. To learn how to fabricate an off-center flat oval to rectangular transformer.

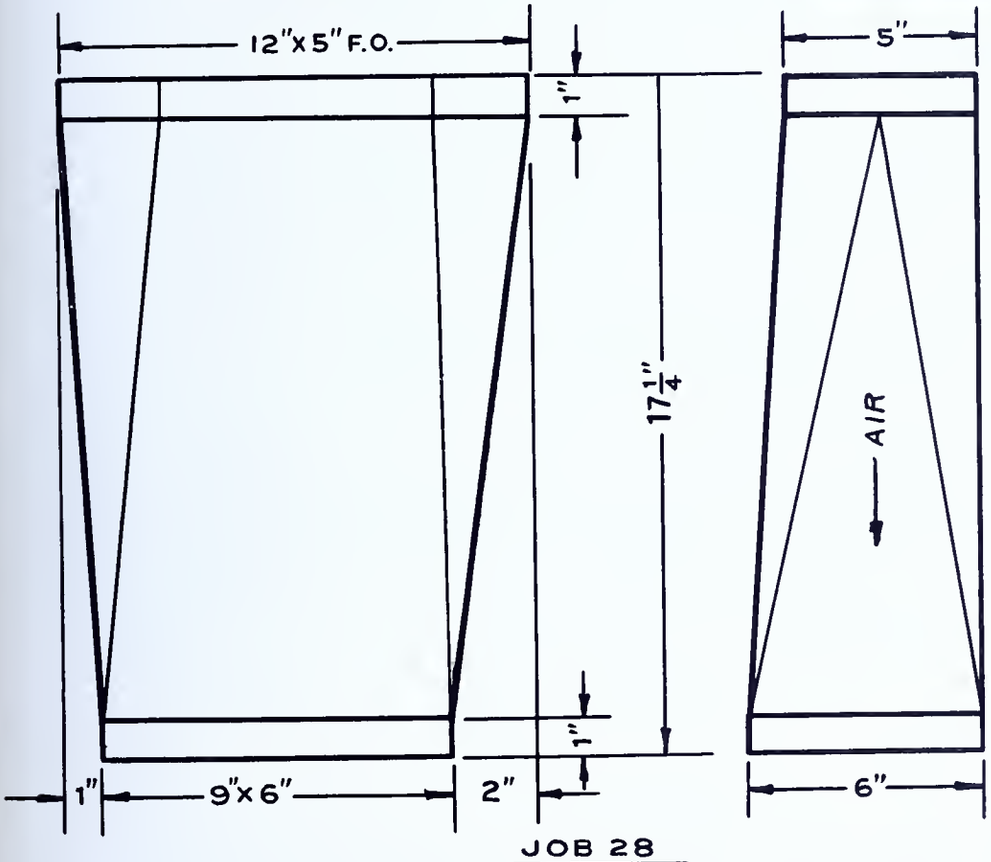
General Information:

This transformer is used in the ventilation system to make a connection between a flat oval shaped duct and a rectangular shaped duct. (Review "General Information" of Job No. 26.)

Specifications:

1. Dimensions: 6" x 9" rectangle to 5" x 12" F.O.
2. All seams and rivets to be soldered fume-tight.
3. Rectangular end to be a "small end".
4. Metal: 22 gauge (.031) galvanized sheet steel.

OFF-CENTER FLAT OVAL
TO RECTANGULAR REDUCER



JOB 28
FLAT OVAL TO RECTANGULAR TRANSFORMER

Tools needed:

1. Metal gauge
2. Tape rule
3. Scriber
4. Punch
5. Straight shears
6. Riveting hammer
7. Hand punch (No. 5 Jr.)
8. File
9. Rivet set
10. Mallet
11. Soldering coppers

Equipment needed:

1. Square shear
2. Slip roll
3. Cornice brake or pipe, box and pan former
4. Stakes as needed
5. Gas furnace

Materials needed:

1. Metal: One piece 22 gauge (.031) approximately 20" x 31".
2. Tinners' rivets: size 2 lb. as needed.
3. Solder: Half and half as needed.

Procedures:

1. Secure pattern (or develop pattern as directed).
2. Study specifications of job.
3. Select from scrap or stock, metal of required gauge.
4. Measure pattern and using the square shear block out metal to sizes needed.
5. Transfer pattern to metal.
6. Cut out and notch body of transformer.
7. Punch rivet holes.
8. Deburr holes and edges.
9. Form transformer in brake. (Review "Method of Braking" outlined in procedures of Job 26)
10. Rivet seam of transformer.
11. Solder fume-tight. Do not solder corners of rectangular end. This soldering is done in assembly.
12. Clean off all remains of flux.

References:

1. See References for Job 28.
2. Job No. 26 - "Fabricate a Central Rectangular to Round Transformer".

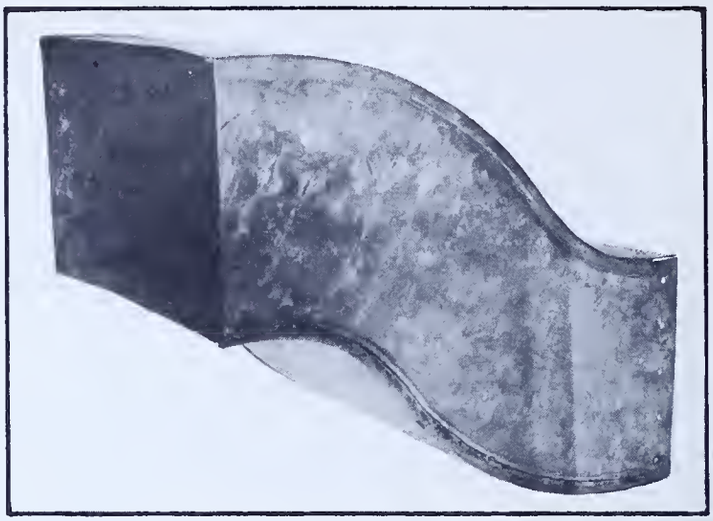
Questions:

1. What is the decimal equivalent for 22 gauge?
2. Why are the rivets used in this job called "2 lb." rivets?
3. What is the cross sectional area of the rectangular end?
4. What is the cross sectional area of the F. O. end?

FABRICATE A RECTANGULAR OGEE OFFSET

Objective:

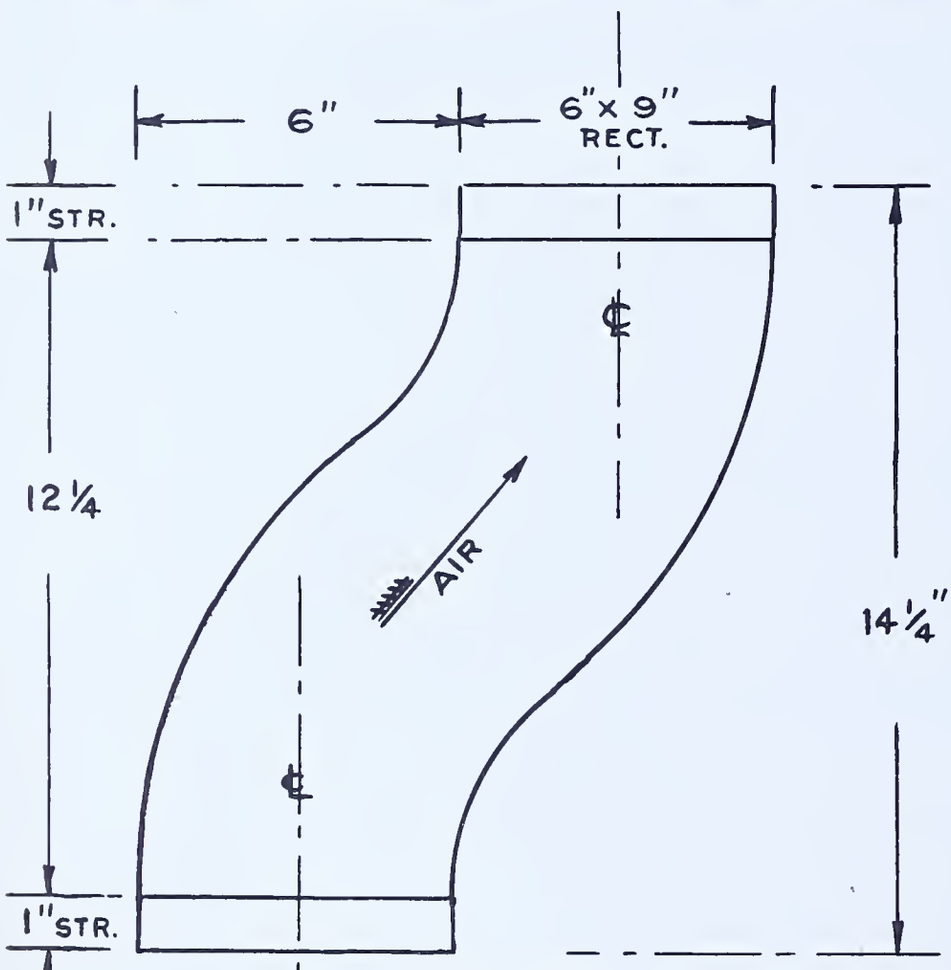
1. To learn how to fabricate a rectangular ogee offset.



RECTANGULAR OGEE OFFSET

General Information:

The offset is a "fitting" used to change the direction of a vent line when obstructions arise in the straight path of the duct. These obstructions may be structural members or part of the mechanical equipment. When designing an offset it is very important that the cross sectional area be maintained. Rectangular offsets can be fabricated by riveting, double seaming, Pittsburgh Lock, gas or arc welding, and spot welding. The offset made in this job is joined together by Pittsburgh Lock seams. When the Pittsburgh seam is used there is a slight decrease in the cross sectional area. This is caused by offsetting the seam toward the inside. This type seam is not customary in naval work. However, it is used in marine work.



JOB 29— OGEE OFFSET RECTANGULAR

Specifications:

1. Dimensions: 6 x 9 rectangle.
2. Offset dimension: 6 inches on the 6" side.
3. Seams: Pittsburgh Lock.
   Soldered fume-tight.
4. One end to be joggled to form a "large end".
5. Metal: 22 gauge (.031) galvanized sheet steel.

Tools needed:

1. Metal gauge
2. Tape rule
3. Scriber
4. Punch
5. Riveting hammer
6. Straight shears
7. Circular shears
8. Hand punch (No. 5 Jr.)
9. 10" half-round smooth file.
10. Dolly
11. Flat nose pliers
12. Mallet
13. Soldering coppers

Equipment needed;

1. Square shear
2. Cornice brake
3. Turning machine
4. Slip roll
5. Stakes as needed
6. Gas furnace

Materials needed:

1. Metal: One piece-22 gauge (.031) to suit pattern of cheek. Cut two cheeks.
   Note: If scrap large enough cannot be found, cut a piece approximately $14\frac{1}{2}$" x 22" from stock and "nest" pattern to obtain 2 cheeks.
   Two pieces-22 gauge (.031) approximately 11" x $16\frac{1}{2}$" for "wrappers".
2. Solder: Half and half, as needed.

Procedure:

1. Secure patterns (or develop patterns as directed).
2. Study specifications of job.
3. Select scrap or stock metal of required gauge.
4. Measure patterns and block out metal to sizes needed on square shear.
5. Transfer patterns to metal.
6. Cut out and notch cheeks.
7. Cut out and notch wrappers.
8. Joggle cheeks and wrappers. Refer to pattern layout.
9. Turn flanges on cheeks.
10. Dress up flanges.

11. Shape wrappers on slip roll.
    Note: Use a cheek as a shape template.

12. Form Pittsburgh Lock on wrappers using cornice brake.
    Note: The braking operation will tend to remove some of the contour from the wrappers.

13. Reshape wrappers to correct contour. Do this by hand on a suitable stake using a cheek for a shape template.

14. Assemble a cheek to a wrapper.

15. Attach remaining wrapper to the assembled cheek and wrapper.

16. Assemble remaining cheek to wrappers.

17. Solder fume-tight.

18. Clean off all remains of flux.

References:

1. See References for Job No. 29.

2. Reference P - "How to Make a Joggle on the Cornice Brake".

3. Reference H - "Pittsburgh Lock Seam".

Questions:

1. What is the cross sectional area of this job?
2. What advantages does the Pittsburgh Lock have over the double seam?
3. Why is the Pittsburgh Lock seam not specified in naval work?
4. State five ways of joining the parts of an offset together.
5. Why do we "nest" irregular shaped blanks?

FABRICATE A N.W.T. CIRCULAR OFFSET

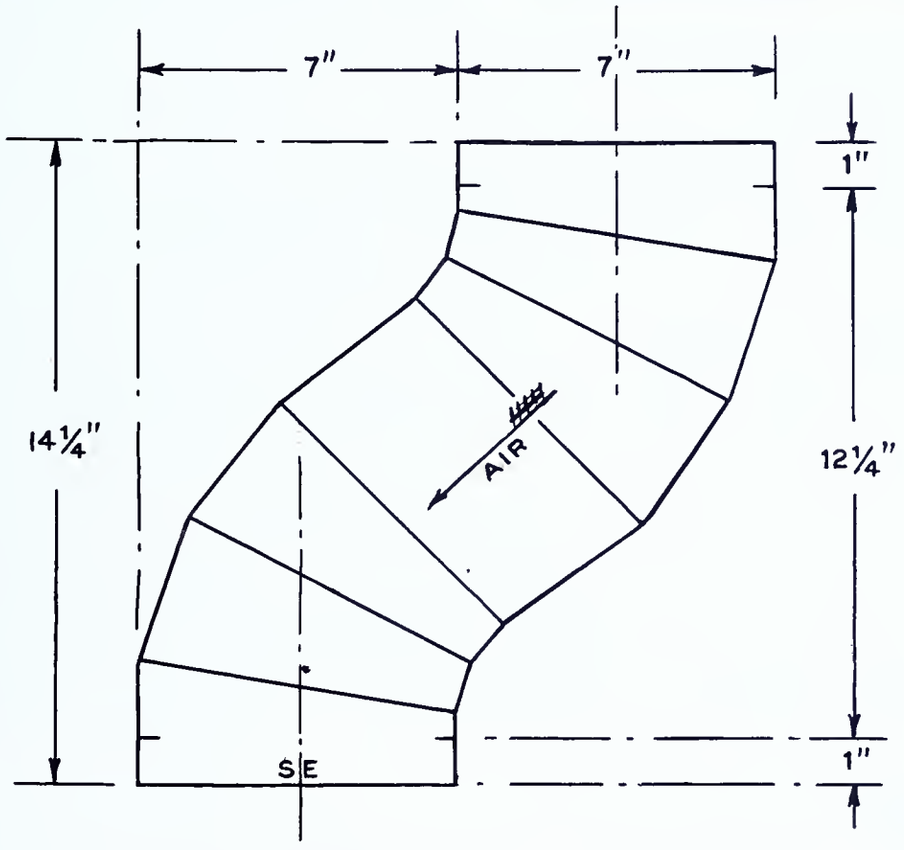
Objectives:

1. To learn how to fabricate a circular offset.
2. To learn how to layout the sections of an offset from a pattern.

General Information:

A circular offset is used to by-pass an obstacle in the course of a straight run of circular pipe. Circular offsets can be fabricated by gas or arc welding, peening, riveting and electric spot welding. This job is riveted and soldered. It would be classed as a N.W.T. offset. A W.T. offset would be fabricated by gas or arc welding.

N. W. T. CIRCULAR OFFSET



JOB 30— SEVEN PIECE ROUND OFFSET

Specifications:

1. Dimensions: Diameter, 7 inches, offset 7 inches.
2. Seams: Riveted and soldered fume-tight.
3. One end to be a small end.
4. Metal: 18 gauge (.050) galvanized sheet steel.

Tools needed:

1. Metal gauge
2. Tape rule
3. Punch
4. Scriber
5. Riveting hammer
6. Hand punch, (No. 5 Jr.)
7. 10 inch, half round smooth file
8. Rivet set
9. Mallet
10. Soldering coppers

Equipment needed:

1. Square shear
2. Throatless lever shear
3. Slip roll
4. Stakes as needed
5. Gas furnace

Materials needed:

1. Metal: One piece 18 gauge (.050) approximately 21-1/2" x 23-1/2".
   Note: This job can be cut from smaller pieces if necessary. Consult the instructor.
2. Tinners' rivets, as needed.
3. Solder: half and half, as needed.

Procedure:

1. Secure pattern (or develop pattern as directed).
2. Study specifications.
3. Select scrap or stock metal of required gauge.
4. Square shear a blank. Refer to pattern layout drawing for dimensions.
5. Transfer pattern to metal.
6. Cut out and notch sections. This can be done on any shear.
7. Punch all rivet holes.
8. Deburr rivet holes and sheared edges.
9. Roll pieces to form 7 inch diameter sections.
   Note: Arrange pieces so that after rolling the seams will all be on one side. See pattern layout drawing.
10. Rivet seams of each section.
11. Shrink flange of mitered end of large end section.

12. Shrink and stretch flanges of intermediate sections.

13. Stretch flange of small end section.

14. Rivet the large end to one of the intermediate sections.

15. Rivet into place the remaining intermediate sections.

16. Rivet small end section into place.

17. Dress up flanges between rivets so that they fit tightly against each other.

18. Solder fume-tight.

19. Clean off all remains of flux.

Questions:

1. What is the difference between a N.W.T. and a W.T. Offset?
2. What size tinners' rivets were used?
3. How was the rivet size, rivet set size and the hole size determined?
4. What tool was used to stretch the flanges?
5. Why was it necessary to stretch and shrink the flanges?

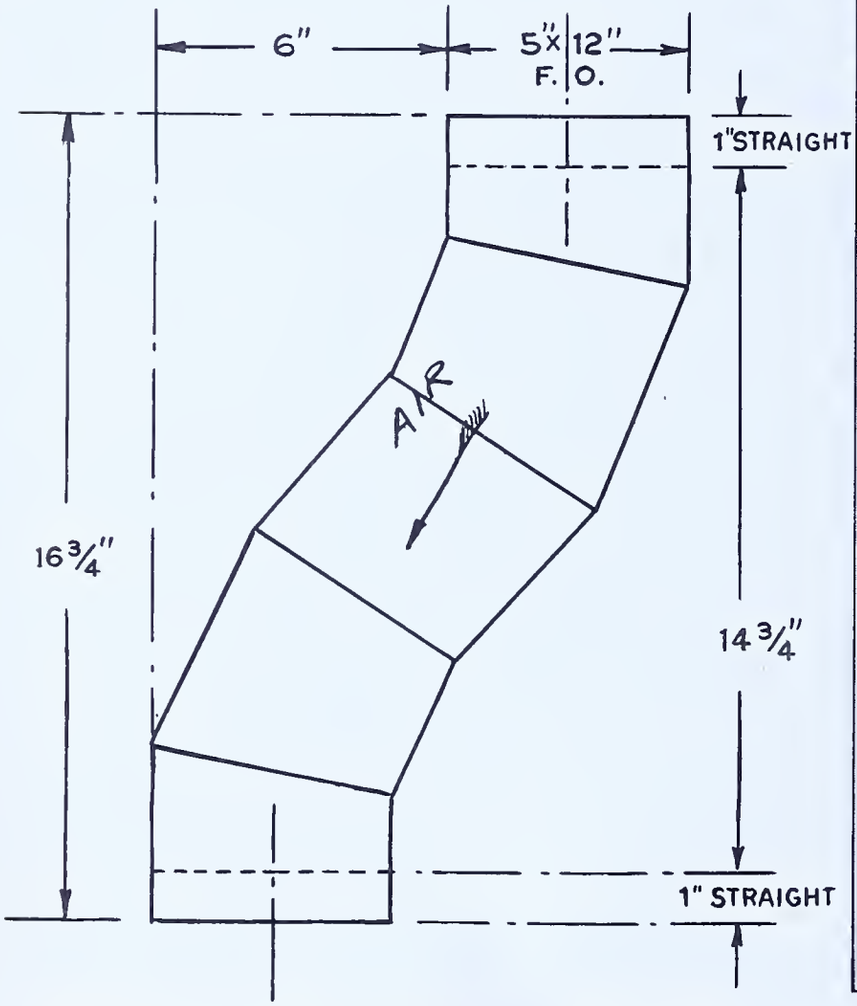
FABRICATE A FIVE PIECE FLAT OVAL N.W.T. OFFSET

Objective:

1. To learn how to fabricate a flat oval N.W.T. offset.

General Information:

A flat oval offset is used to by-pass an obstacle in the course of a straight run of flat oval pipe. Flat oval offsets can be fabricated by gas or arc welding, peening, riveting and electric spot welding. This job is riveted and soldered. It would be classed as a N.W.T. offset. A W.T. offset would be fabricated by gas or arc welding.



JOB 31 — FLAT OVAL OFFSET

FLAT OVAL N. W. T. OFFSET

Specifications:

1. Dimensions: Flat oval, 5" x 12", offset, 6".
2. Seams: Riveted and soldered fume-tight.
3. One end to be a small end.
   Note: Pattern dimensions necessitate the use of a blank.
4. Metal: 22 gauge (.050) galvanized sheet steel.

Tools needed:

1. Metal gauge
2. Tape rule
3. Punch
4. Scriber
5. Riveting Hammer
6. Hand punch (No. 5 Jr.)
7. 10 inch, half round, smooth file
8. Rivet set
9. Mallet
10. Soldering coppers
1. Square shear
2. Throatless lever shear
3. Slip roll
4. Stakes as needed
5. Gas furnace

Materials needed:

1. Metal: one piece 22 gauge (.031) approximately 23" x 31".
   Note: This job can be cut from smaller pieces if necessary. Consult the instructor.
2. Tinners' rivets, as needed.
3. Solder: Half and half, as needed.

Procedure:

1. Secure pattern (or develop pattern as directed).
2. Study specifications of job.
3. Select scrap or stock metal of required gauge.
4. Square shear a blank. Refer to pattern layout drawing for dimensions.
5. Transfer pattern to metal.
6. Cut out and notch sections. This can be done on shear.
7. Punch all rivet holes.
8. Deburr rivet holes and sheared edges.
9. Roll pieces to form 5" x 12" F. O. sections.
   Note: Arrange pieces so that after rolling, the seams will all be on one side. See pattern layout drawing.
10. Rivet seams of each section.
11. Shrink flange of mitered end of large end section.

12. Shrink and stretch flanges of intermediate sections.

13. Stretch flange of small end section.

14. Rivet the large end to one of the intermediate sections.

15. Rivet into place the remaining intermediate sections.

16. Rivet small end section into place.

17. Dress up flanges between rivets so that they fit tightly against each other.

18. Solder fume-tight.

19. Clean off all remains of flux.

Questions:

1. What purpose does an offset serve?
2. Why is the offset made in this job classed as a N.W.T. offset?
3. What is the correct size rivet for this job?
4. Which end of the offset is notched?

FABRICATE A HANGER FOR N.W.T. CIRCULAR PIPE

Objectives:

1. To learn how to fabricate a hanger.
2. To become familiar with information on hangers for different types of pipes and ducts.

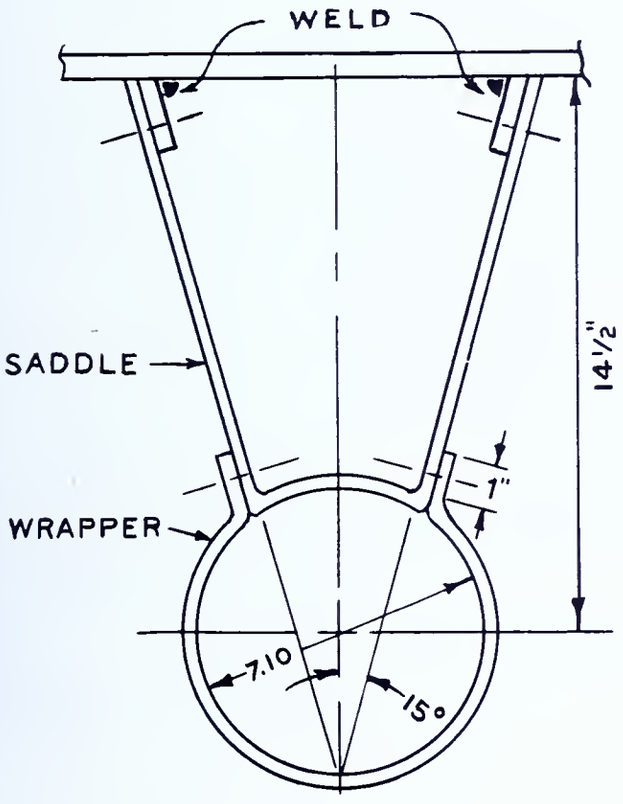
General Information:

Hangers used to support marine sheet metal ventilation ducts are made from M. S. flat bar stock. They are designed to support and brace the ducts. Their design must allow for removal of the duct whenever cleaning or repairs are necessary.

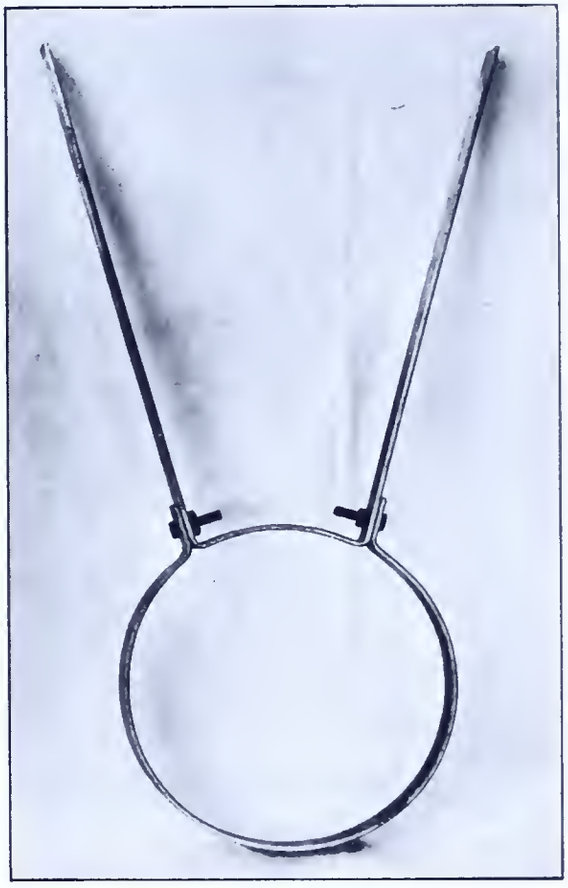
Hangers for N.W.T. ducts consist of two parts, the saddle and the wrapper. The ends of the saddle are bolted to lugs which are welded to the underside of the deck. The wrapper fits around the duct and is bolted to the saddle.

Hangers for W.T. ducts consist of four parts, two lugs and two braces. The lugs are welded on the pipe approximately 35° from the center line. The braces are bolted to the lugs and welded to the underside of the deck. Sheet four shows various types and size specifications of hangers.

Hanger saddles are usually cut longer than needed and length is cut on job to suit requirements.



JOB 32



N. W. T. CIRCULAR PIPE HANGER

Specifications:

1. Hanger to be made 1" x 1/8" M. S. bar stock.
2. Shape to be circular to fit 7" diameter 18 gauge (.050) pipe.
3. Under side of deck to center line of pipe (X measurement) to be 14-1/2".
4. Design to be N.W.T. "saddle" type.
5. Holes to be 9/32" diameter for 1/4" bolts.

Tools needed:

1. Metal gauge
2. Tape rule
3. Combination square
4. Scriber
5. Center punch
6. Riveting hammer
7. Hand punch (No. 2)
8. Mallet

Equipment needed:

1. Lever shear
2. Floor or bench grinder
3. Heavy duty slip roll
4. Wire and brace bender

Material needed:

1. Metal: One piece 1" x 1/8" galvanized bar stock 27-1/8" long.
   One piece 1" x 1/8" galvanized bar stock 20-5/8" long.
   Two pieces 1/4"-20 R.H. (Round Head) steel cad. plated, screws 7/8" long.
   Two pieces 1/4"-20 steel cad. plated hex nuts.
   Two pieces 1/4" steel, cad. plated lock washers.

Procedure:

1. Secure full size layout template (or develop template as directed).
2. Study specifications of job.
3. Select from flat bar stock pieces from which the required lengths can be cut.
4. Cut to length on lever shear.

   Note: Return to stock any pieces of scrap that are 1" or longer.

5. Layout pieces as per dimensions. Refer to Fig. 1 Pattern Layout.
6. Center punch bolt holes.
7. Center punch bend lines.
8. Punch or drill bolt holes.

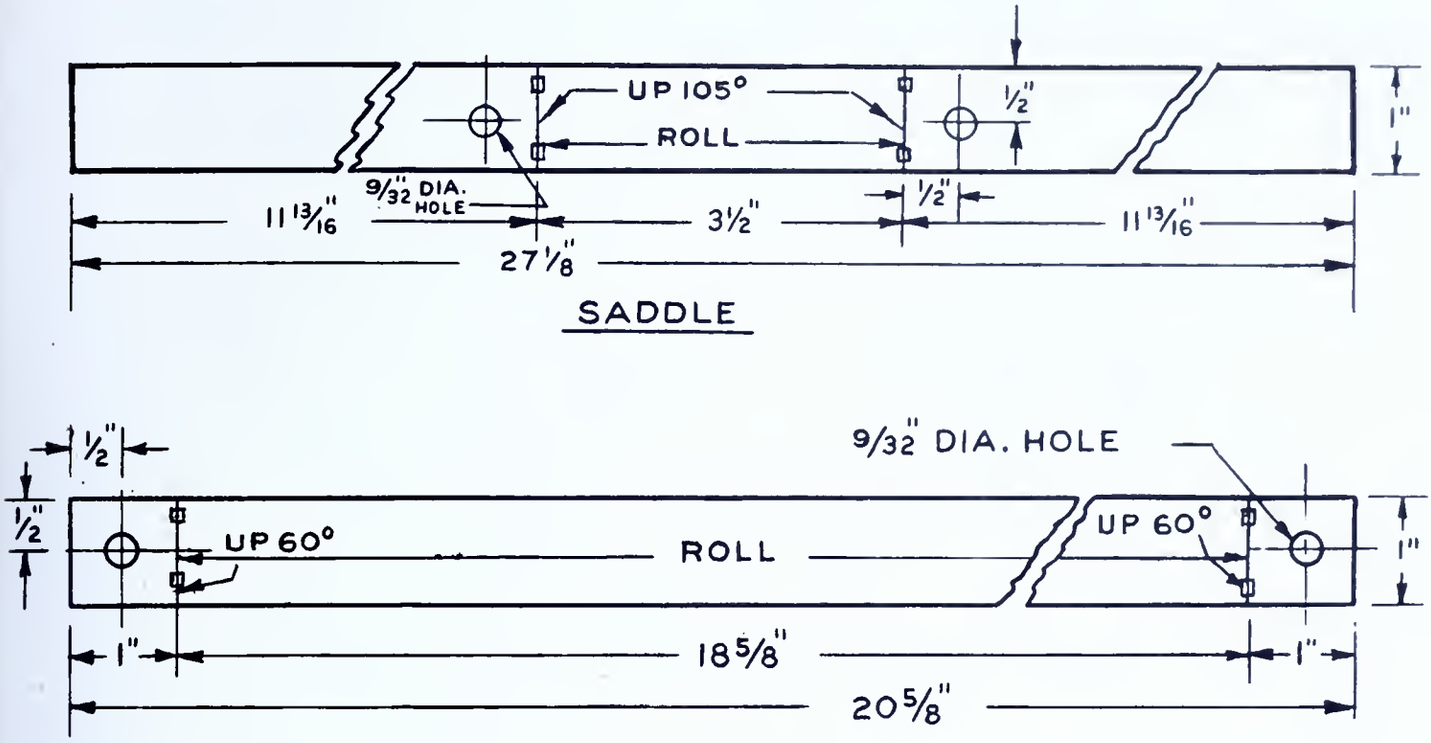


FIG. 1 — PATTERN LAYOUT

9. Deburr holes and sheared ends on the grinder.

10. Contour that part of each piece which contacts the pipe. Do this on the heavy duty slip roll.

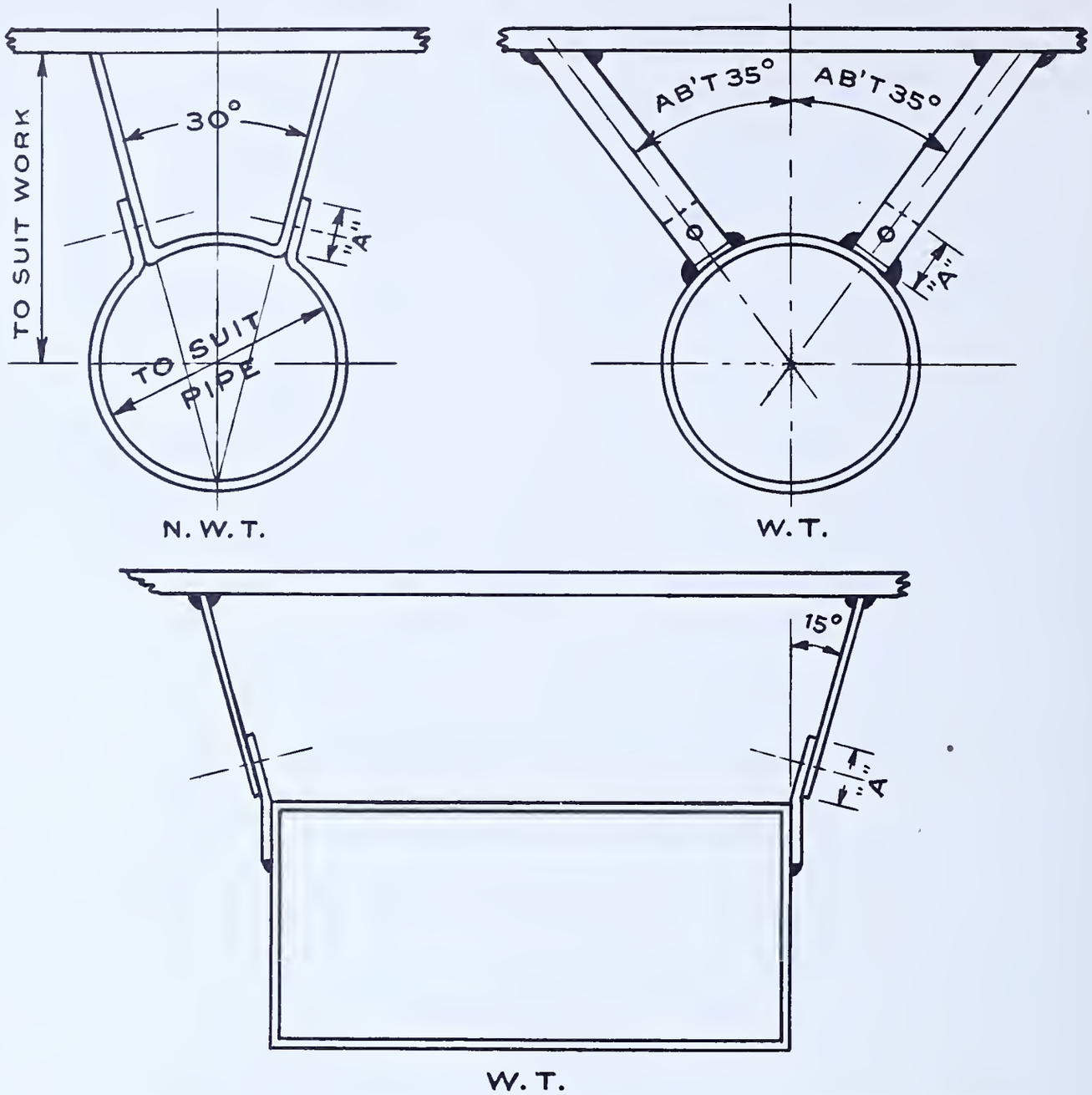
    Note: When contouring parts of hanger see that the bend line center punch marks come on the outside of the curve.

11. Bend the straight sections of the pieces to the specified angles in the wire and brace bender.

12. Dress up and check parts with full size layout template.

Questions:

1. State two reasons why hangers are used.
2. Why are pieces of scrap 1" or longer returned to stock?
3. Referring to Procedure No. 10, why are the bend line center punch marks kept on the outside of the curve as instructed in Procedure No. 10?
4. What is the X measurement of this hanger?
5. Why does Procedure No. 10 come before Procedure No. 11?



DIA. OF PIPE	SIZE OF FLAT BAR				DIA. OF BOLTS	"L" OF BOLTS
	N.W.T.	W.T.	ALUM	"A"		
2½" to 8"	1" x 1/8"	1" x 1/8"	1" x 1/8"	1"	¼"	7/8"
8½" to 11½"	1" x 3/16"	1" x 3/16"	1" x 1/8"	1-1/8"	5/16"	1"
12" to 14½"	1" x 3/16"	1½" x ¼"	1" x 3/16"	1-1/8"	3/8"	1"
15" to 24"	1½" x ¼"	1½" x 5/16"	1" x 3/16"	1-1/8"	3/8"	1"
Over 24"	1½" x ¼"	2" x 3/8"	1½" x ¼"	1-1/8"	½"	1¼"

FIG. 2 — TYPES OF HANGERS

FABRICATE DROP RECTANGULAR ELBOW

Objectives:

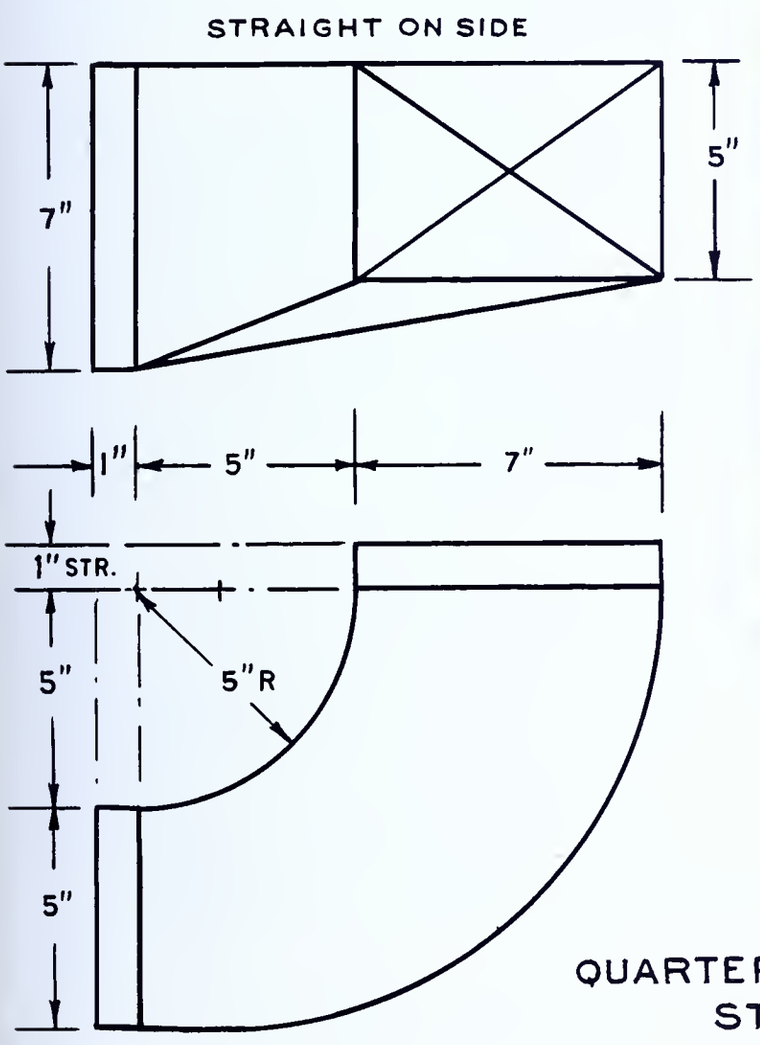
1. To learn how to fabricate a drop rectangular elbow.
2. To learn how to lay out a drop rectangular elbow.

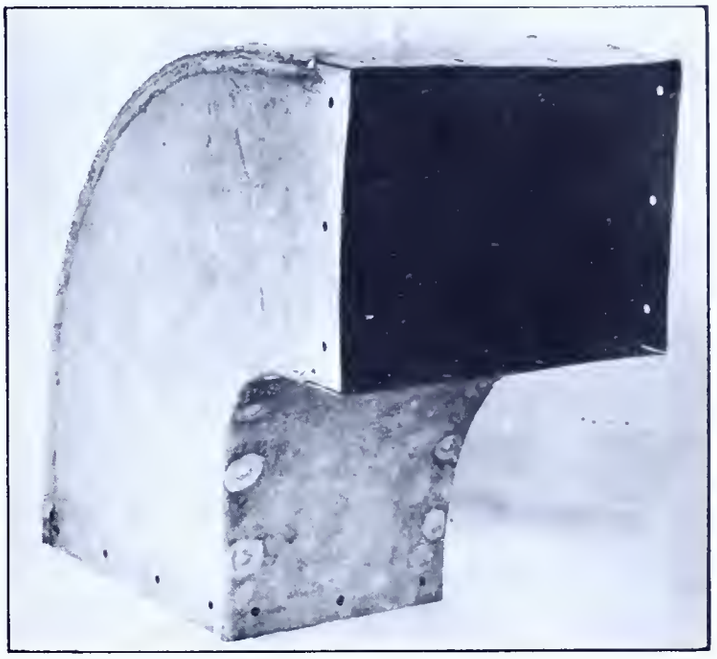
General Information:

Sometimes the dimensions of a shape are reversed, (thus maintaining the same area), in order to gain head-room, to make a necessary shift, or to clear obstructions. A drop rectangular elbow does this. It is often used in connecting main line to a blower.

Specifications:

Metal: 18 gauge (.050) galvanized sheet steel.
Seams to be riveted and soldered.
To be laid out with large and small end.
Rivets approximately 2" ℄ to ℄.
Rivet holes in large end only.





DROP RECTANGULAR ELBOW

JOB 33
QUARTER TURN RECT. ELBOW
STRAIGHT ON SIDE

Tools needed:

1. Scriber
2. Center punch
3. Square
4. Dividers
5. Riveting hammer
6. Hand punch
7. Soldering coppers
8. Rule
9. Lever shears
10. Rivet set
11. Drift pins
12. Dolly bar

Equipment needed:

1. Square shears
2. Roll
3. Brake
4. Gas furnace
5. Mandrel

Materials needed:

1. Metal: 18 gauge (.050) galvanized sheet steel
   One piece approximately 13" x 11" for Cheek (Strt. side)
   One piece approximately 15" x 13" for Cheek (Offset)
   One piece approximately 10" x 7" for Throat
   One piece approximately 20" x 7" for Heel
2. Rivets
3. Bar solder

Procedure:

1. Secure pattern.
2. Study specifications of job.
3. Select metal of required gauge and shear to size and shape.
4. Cut out cheeks, with lever shear.
5. Cut out heel and throat with power shear or jump shear.
6. Punch rivet holes and deburr edges.
7. Shape cheeks and heel.
8. Remove roll from heel and throat.
9. Turn up edge allowed on brake.
10. Reshape heel and throat to necessary radius.
11. Assemble cheeks to heel and to throat temporarily with bolts or screws. This temporary assembly is for purpose of checking.
12. Rivet cheeks to heel
13. Rivet throat piece to above assembly.
14. Solder
15. Clean

Questions:

1. Why is an elbow of this type used?
2. Why do we roll this job and then remove the roll before flanging?
3. What size rivets should be used?
4. Why is it important to maintain the cross-sectional area?

FABRICATE A CENTRAL Y BRANCH

Objectives:

1. To learn purpose of central Y branch.

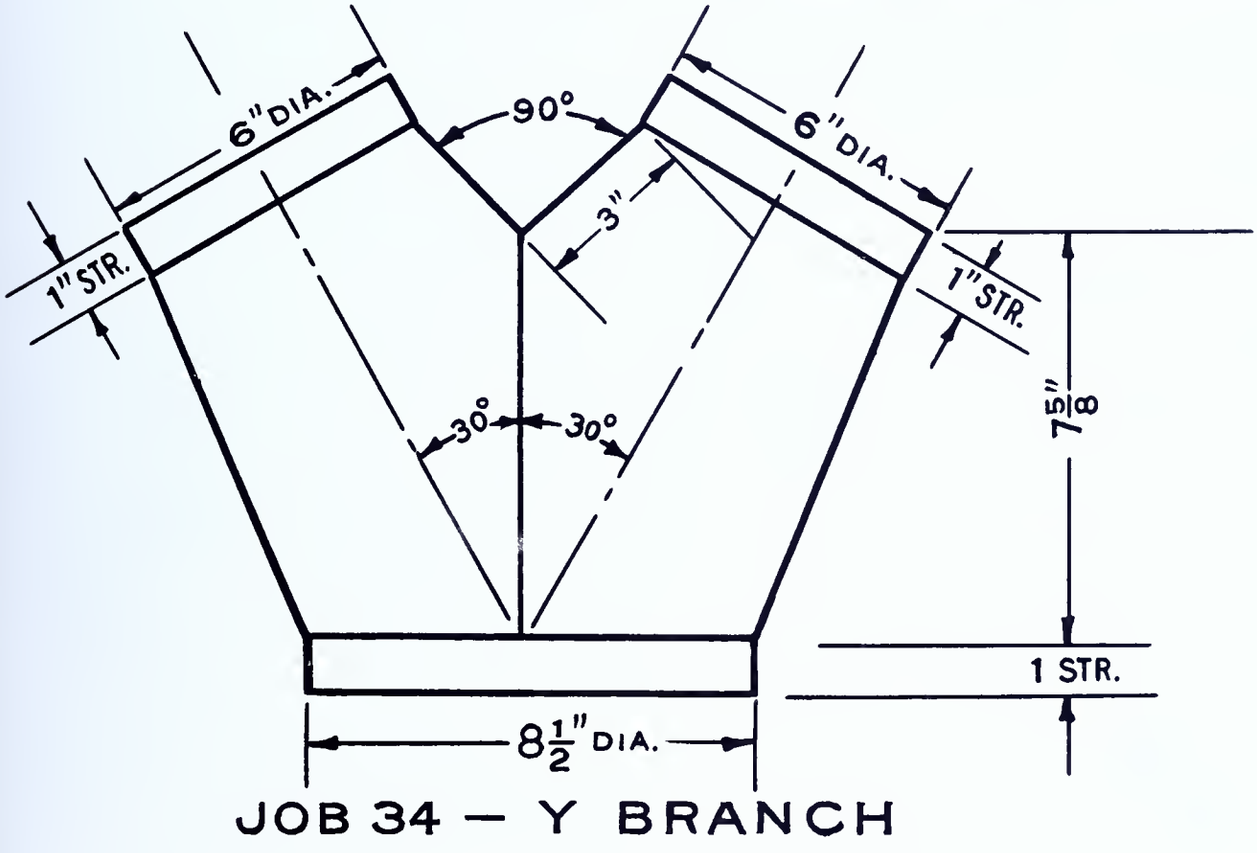
2. To learn how to fabricate a central Y branch.

General Information:

This shape is usually used at the point of a main line where the air flow is to be divided equally. Y branches are used in a location where too many fittings would be cumbersome.

The sum of the cross sectional areas of the two branch lines must equal the area of the main.

CENTRAL Y BRANCH



JOB 34 — Y BRANCH

Specifications:

1. 20 gauge (.038) galvanized sheet steel.
2. Seams - riveted and soldered.
3. Standard lap allowance.

Tools needed:

1. Scriber
2. Center punch
3. Square
4. Dividers
5. Riveting Hammer
6. Hand punch
7. Soldering coppers
8. Rule
9. Lever shears
10. Rivet set
11. Drift pins
12. Dolly bar

Equipment needed:

1. Square shears
2. Roll
3. Brake
4. Gas furnace
5. Mandrel

Materials needed:

Bar solder
20 gauge (.038) Metal: two pieces approximately 25" x 15".
Rivets

Procedure:

1. Secure pattern.
2. Study specifications of job.
3. Select metal of required gauge and shear to size and shape.
4. Cut out the two halves on lever shears.
5. Notch knockover.
6. Punch rivet holes and deburr edges.
7. Roll the two halves to suit in the roller.
8. Rivet the throat of each half.
9. Stretch the 1" straight on the small ends to fit required size.
10. Assemble into one unit, riveting and turning "knockover" to tighten in crotch. ((see pattern).
11. Stretch large opening to fit required size.
12. Solder.
13. Clean.

Questions:

1. Why do we use this fitting?
2. Why do we stretch the small end openings before assembling?
3. What should the combined areas of the two ends be?

ASSEMBLE SHAPES INTO SUB-ASSEMBLIES

Objective:

1. To learn how to assemble sub-assemblies.

General Information:

Ventilation systems are divided into assemblies. Assemblies if too large for handling are divided into sub-assemblies. The jobs made in this series are arranged so that they can be assembled into five sub-assemblies. Add hangers and flanges where needed.

Specifications:

1. Sub-assembly No. 2 to consist of jobs 25, 27, 9a and 9c.
2. Sub-assembly No. 3 to consist of jobs 9a, 24, 19b, 14, 15, 19a, 16, 20, 18, 21, 30, and 26.
3. Sub-assembly No. 4 to consist of jobs 23, 17, 22, 12, and 11.
4. Sub-assembly No. 5 to consist of jobs 29, 28, 31, 13, 32 and 9b.
5. Joints to be riveted with tinners' rivets and soldered fume-tight.
   Note: See Fig. 1 for arrangement of jobs into sub-assemblies.

Tools needed:

1. Riveting hammer
2. Mallet
3. Rivet sets, sizes as needed
4. Scriber
5. Drift pin
6. Center punch
7. Dolly
8. Screw driver
9. Sheet metal screws, as needed
10. Drills, sizes as needed
11. Hand shears, types and sizes as needed
12. Hand punch, sizes as needed
13. Soldering coppers

Equipment needed:

1. Electric or air hand drill
2. Stakes as needed
3. Gas furnace

Materials needed:

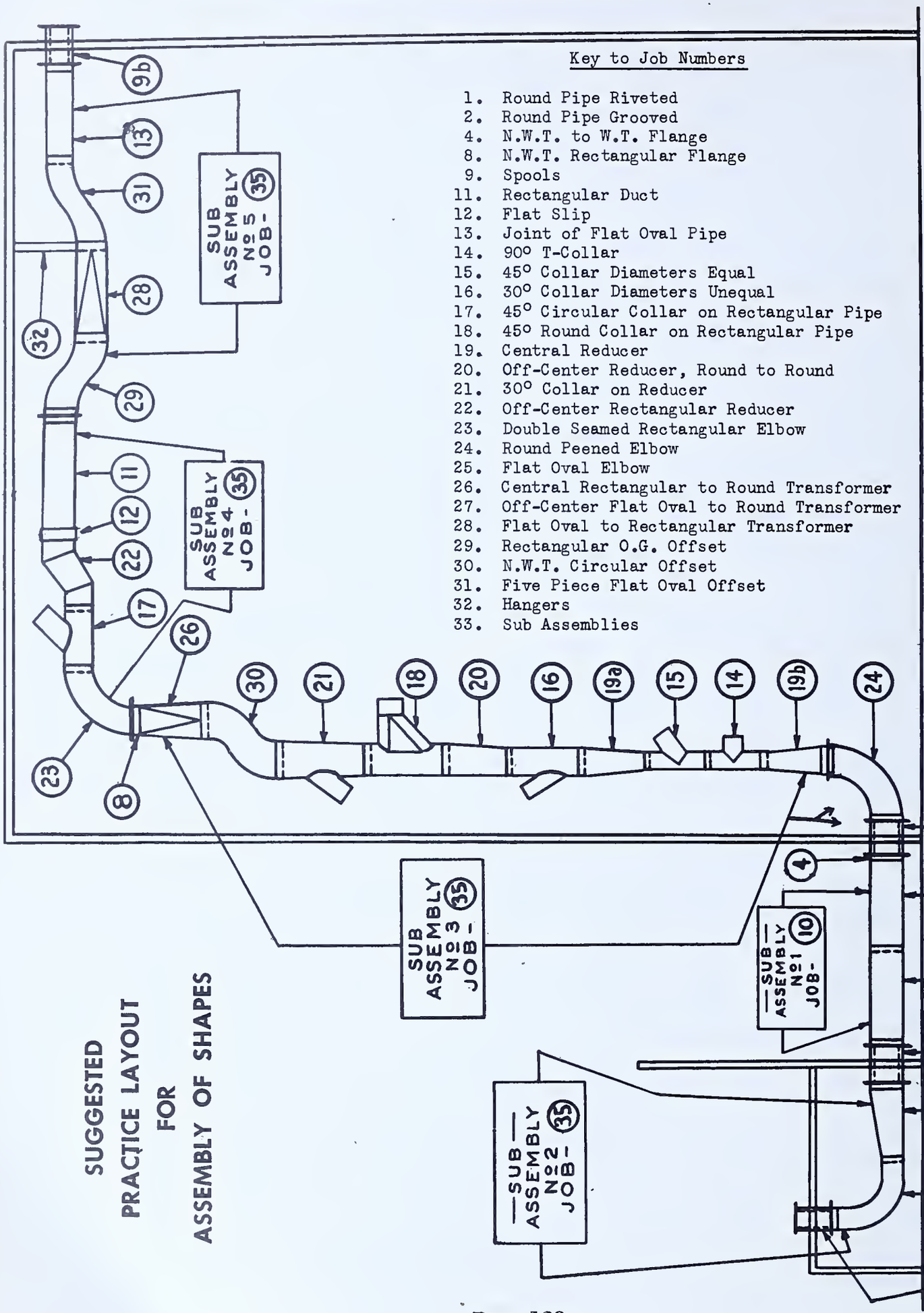
1. Rivets: sizes as needed.
2. Solder: half and half as needed.

Procedure:

1. Follow steps in Job No. 10.

Reference:

1. Job No. 10, Assemble Pipe Sections and Fit to Spools


Key to Job Numbers
1. Round Pipe Riveted
2. Round Pipe Grooved
4. N.W.T. to W.T. Flange
8. N.W.T. Rectangular Flange
9. Spools
11. Rectangular Duct
12. Flat Slip
13. Joint of Flat Oval Pipe
14. 90° T-Collar
15. 45° Collar Diameters Equal
16. 30° Collar Diameters Unequal
17. 45° Circular Collar on Rectangular Pipe
18. 45° Round Collar on Rectangular Pipe
19. Central Reducer
20. Off-Center Reducer, Round to Round
21. 30° Collar on Reducer
22. Off-Center Rectangular Reducer
23. Double Seamed Rectangular Elbow
24. Round Peened Elbow
25. Flat Oval Elbow
26. Central Rectangular to Round Transformer
27. Off-Center Flat Oval to Round Transformer
28. Flat Oval to Rectangular Transformer
29. Rectangular O.G. Offset
30. N.W.T. Circular Offset
31. Five Piece Flat Oval Offset
32. Hangers
33. Sub Assemblies
SUB ASSEMBLY No 5 JOB- 35
SUB ASSEMBLY No 4 JOB- 35
SUB ASSEMBLY No 3 JOB- 35
SUB — ASSEMBLY No 1 JOB- 10
SUB — ASSEMBLY No 2 JOB- 35
SUGGESTED PRACTICE LAYOUT FOR ASSEMBLY OF SHAPES

ERECT AND TEST FINAL ASSEMBLY

Objective:

1. To learn how to assemble sub-assemblies.

General Information:

The final assembly of sub-assemblies involves erecting sub-assemblies to flanged spools and supporting with hangers.

Specifications:

1. Sub-assemblies 2, 3, 4, and 5 to be assembled into one final assembly as shown in Fig. 1 of Job No. 35.

Tools needed:

1. Wrenches, sizes as needed
2. Riveting hammer
3. Mallet
4. Scriber
5. Rivet sets, sizes as needed
6. Drift pin
7. Center punch
8. Punch
9. Dolly
10. Screwdriver
11. Sheet metal screws
12. Dolly, sizes as needed
13. Hollow punches, sizes as needed
14. Hand shears, types and sizes as needed
15. Soldering coppers.
16. File
17. Hack saw.

Equipment needed:

1. Electric hand drill
2. Gas furnace

Materials needed:

1. Rivets: sizes as needed
2. Solder: half and half as needed
3. Bolts, nuts and washers: sizes as needed
4. Wicking for making grommets: as needed
5. Gasket material as needed
6. Sub-assemblies made up in job No. 35.

Procedure:

1. Refer to Job No. 10.

Reference:

1. Job Sheet No. 10 --- "Assemble Pipe Sections and Fit to Spools"

2. Reference R - "Air-Test of Fume-Tight Vent Assemblies"

TYPES OF SHEET METALS

Sheet Steel:

A low-carbon steel made by rolling. Sheet steel is obtainable in many gauges or thicknesses. It frequently is alloyed with other metals, such as copper and nickel to impart corrosion-resistant qualities and also to improve the toughness, strength, and ductility of the metal.

Galvanized "Iron" or Galvanized Sheet Steel:

A low-carbon sheet steel which has been coated with zinc alloy by means of hot dipping or by heating in a furnace. Without further qualification, galvanized iron is practically synonymous with galvanized sheet steel. It should be noted that many objects made of cast iron, steel plate, etc., are galvanized by hot dipping after fabrication.

Steel Plate:

A low-carbon steel which has been rolled into sheets heavier than $\frac{1}{4}$".

Tin Plate:

A thin sheet of steel which has been coated with tin by passing the sheet through a bath of molten tin. Tin plate is seldom used in marine work.

Sheet Copper:

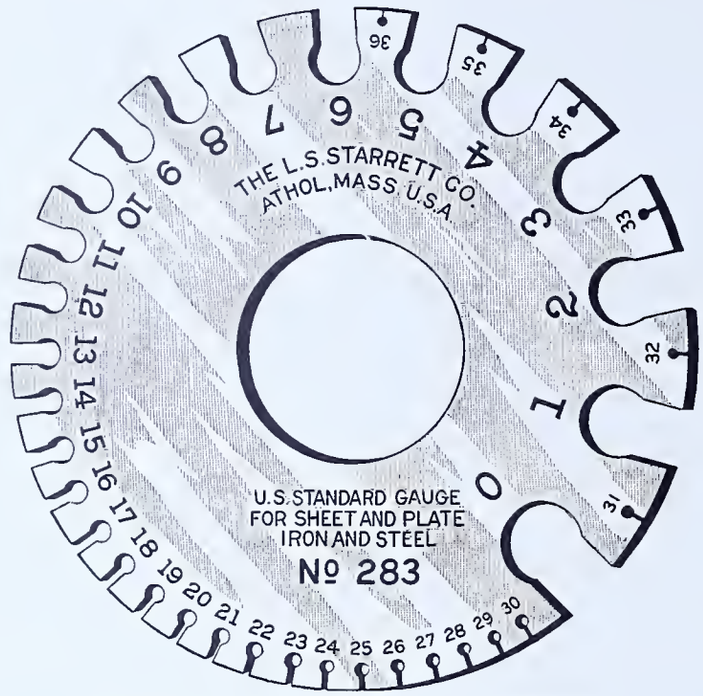
Copper which has been rolled into sheets. Sheet copper may be obtained annealed or hard. The soft or annealed sheets are used where shaping is required. Sheet copper is manufactured in many gauges, widths, and lengths. Copper is highly resistant to the corrosive action of salt water.

Sheet Aluminum:

Rolled sheets of pure aluminum or alloys of aluminum. Sheet aluminum is obtainable in a great many gauges, hardnesses, alloys, widths and lengths. Naval applications of sheet aluminum are numerous; the marine sheet metal worker uses this metal extensively in fabricating ventilation pipes, etc. Aluminum is not highly resistant to the corrosive action of salt spray or salt water.

Recent shortages of aluminum have resulted in the increased use of galvanized steel in much marine work.

USE OF THE SHEET METAL GAUGE


THE L.S.STARRETT CO.
ATHOL,MASS.U.S.A.
U.S.STANDARD GAUGE
FOR SHEET AND PLATE
IRON AND STEEL
№ 283
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36

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U **U. S. STANDARD GAUGE FOR UNCOATED SHEET METAL**

The thickness of sheet metal is designated (1) by "gauge" or (2) by a decimal part of an inch. In gauging sheet metal care must be taken not to force the metal into an opening of the gauge. Since the gauge is hardened steel, it is likely to be broken if pressure is applied.

Since all gauges are made for gauging uncoated sheet metal, it will be found that coated or galvanized sheets usually gauge one number heavier than their nominal gauge. For example: 20 gauge black sheet steel will gauge "20," 20 gauge galvanized sheet steel will gauge approximately "19". We must also remember that lower gauge numbers indicate thicker material.

The accompanying sheet, "Standard United States Gauges of Sheet Steel", indicates gauge numbers and approximate thicknesses in inches, and weights per square foot of uncoated sheets. Gauges 10 to 24 are most frequently used by the marine sheet metal shop worker. It should be noted that the marine sheet metal worker frequently uses metals of 3/16" thickness or heavier, in addition to angles and flat bar of even heavier weight. The trainee should memorize the gauges and decimal equivalents of sheet metal which he uses most frequently.

STANDARD U. S. GAUGES OF SHEET STEEL

The following table gives the gauge numbers and approximate thickness in inches, and weight per square foot of uncoated sheets. It should be noted that galvanized sheets weigh two and one-half (2-1/2) ounces more per square foot than uncoated sheets of the same gauge.

Galvanized sheets when tested will fit into a standard gauge one number lower (the next larger gauge) than uncoated sheets.

No. of Gauge	Weight per Square Foot in Pounds Avoirdupois	Weight per Square Foot in Ounces Avoirdupois	Approximate Thickness in Fractions of an Inch	Approximate Thickness in Decimal Parts of an Inch
0000000	20.00	320	1-2	.5
000000	18.75	300	15-32	.46875
00000	17.50	280	7-16	.4375
0000	16.25	260	13-32	.40625
000	15.	240	3-8	.375
00	13.75	220	11-32	.34375
0	12.50	200	5-16	.3125
1	11.25	180	9-32	.28125
2	10.625	170	17-64	.265625
3	10.	160	1-4	.25
4	9.375	150	15-64	.234375
5	8.75	140	7-32	.21875
6	8.125	130	13-64	.203125
7	7.5	120	3-16	.1875
8	6.875	110	11-64	.171875
9	6.25	100	5-32	.15625
10	5.625	90	9-64	.140625
11	5.	80	1-8	.125
12	4.375	70	7-64	.109375
13	3.75	60	3-32	.09375
14	3.125	50	5-64	.078125
15	2.8125	45	9-128	.0703125
16	2.5	40	1-16	.0625
17	2.25	36	9-160	.05625
18	2.	32	1-20	.05
19	1.75	28	7-160	.04375
20	1.50	24	3-80	.0375
21	1.375	22	11-320	.034375
22	1.25	20	1-32	.03125
23	1.125	18	9-320	.028125
24	1.	16	1-40	.025
25	.875	14	7-320	.021875
26	.75	12	3-160	.01875
27	.6875	11	11-640	.0171875
28	.625	10	1-64	.015625
29	.5625	9	9-640	.0140625
30	.5	8	1-80	.0125
31	.4375	7	7-640	.0109375
32	.40625	6½	13-1280	.01015625
33	.375	6	3-320	.009375
34	.34375	5½	11-1280	.00859375
35	.3125	5	5-640	.0078125
36	.28125	4½	9-1280	.00703125
37	.265625	4¼	17-2560	.006640625
38	.25	4	1-160	.00625

DECIMAL EQUIVALENTS

	1/64	.015625		33/64	.515625
	1/32	.03125		17/32	.53125
	3/64	.046875		35/64	.546875
1/16		.0625	9/16		.5625
	5/64	.078125		37/64	.578125
	3/32	.09375		19/32	.59375
	7/64	.109375		39/64	.698375
1/8		.125	5/8		.625
	9/64	.140625		41/64	.640625
	5/32	.15625		21/32	.65625
	11/64	.171875		43/64	.671875
3/16		.1875	11/16		.6875
	13/64	.203125		45/64	.703125
	7/32	.21875		23/32	.71875
	15/64	.234575		47/64	.734375
1/4		.25	3/4		.75
	17/64	.265625		49/64	.765625
	9/32	.28125		25/32	.78125
	19/64	.296875		51/64	.796875
5/16		.3125	13/16		.8125
	21/64	.328125		53/64	.828125
	11/32	.34375		27/32	.84375
	23/64	.359375		55/64	.859375
3/8		.375	7/8		.875
	25/64	.300625		57/64	.890625
	13/32	.40625		29/32	.90625
	27/64	.421875		59/64	.921875
7/16		.4375	15/16		.9375
	29/64	.453125		61/64	.953125
	15/32	.46875		31/32	.96875
	31/64	.484375		63/64	.984375
1/2		.50	1		1.

HOW TO LAY OUT A WELDED PIPE - STRETCHOUT DIMENSIONS

General Information:

A welded pipe usually involves no problems of large and small ends, since the majority are joined by butt welding. At least every eight feet a flange must be inserted to allow for ease of handling in maintenance care.

The word "stretchout" is used in all pattern developments. It refers to the distance involved in laying out the metal for the diameter of the pipe. To find the "stretchout", the nominal diameter (specified inside diameter) plus one metal thickness (Fig. 1) is multiplied by π (3.1416).

Because the inside surface of metal shrinks when rolled, and since the inside diameter must be maintained, one thickness of metal is added to the nominal diameter to secure the diameter used in determining stretchout.

Stretchout = Nominal Diameter + Thickness x π (3.1416)
Practical method is (Nom Diam x π) + 3 x thickness

Procedure:

1. Find the stretchout of pipe.
2. Square shear blank to rough over all size.
3. Lay off rectangle using length of pipe and stretchout distances for dimensions.
4. Shear to these lines.
5. Roll and shape for welding.
6. Weld.

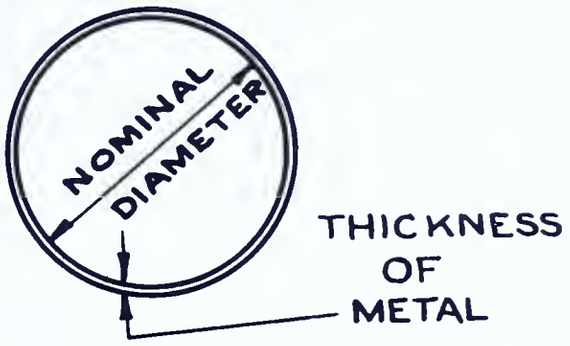


FIG. 1 - ROUND PIPE

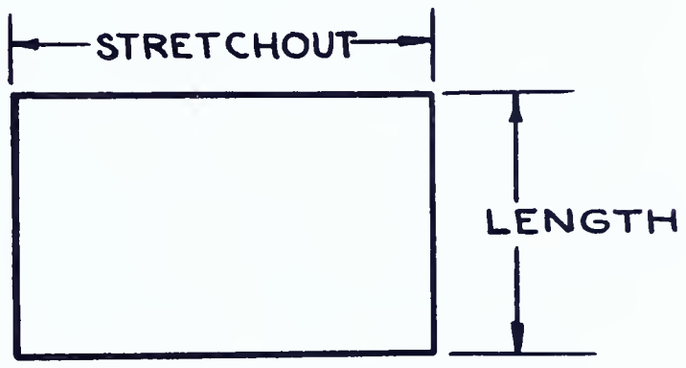


FIG. 2 - PATTERN

Note: This unit does not show allowance for laps. If the pipe is to be grooved refer to N. Y. Information Sheet "Allowance for Grooving". If the pipe is to be riveted, refer to N. Y. Information Sheet "Riveting". Also see Reference D "Layout For Pipe Having Small and Large Ends", which follows.

LAYOUT FOR PIPE HAVING SMALL AND LARGE ENDS

When it is desired that a run of pipe and/or shapes be assembled by means of lapping and riveting, it will be necessary for each joint so assembled to have a large end and small end, as illustrated in Fig. 1.

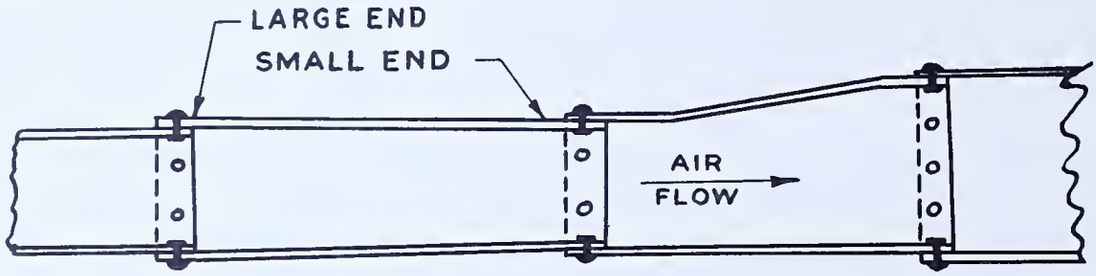


FIG. 1 — SECTION OF A RUN SHOWING METHOD OF JOINING

In naval work the nominal diameter of the pipe is the diameter measured on the inside of the small end. See Fig. 2.

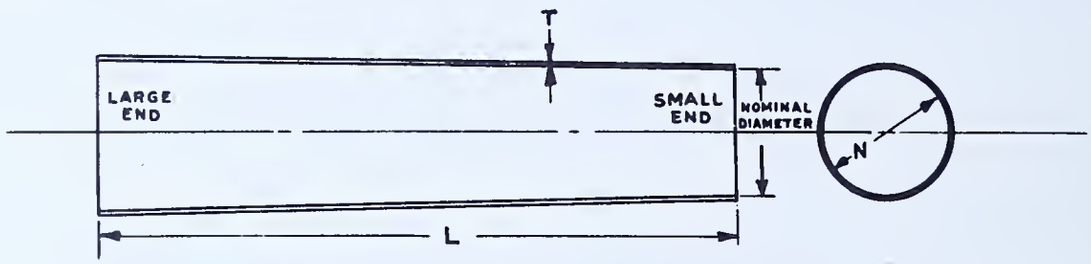


FIG. 2 — PIPE WITH LARGE AND SMALL END

A pattern or layout for a joint of pipe is required, - the specifications for which are as follows:

N (nominal diameter) = 6"
L (length) = 17-3/4"
T (metal thickness) = 20 gauge (.038")

How to Calculate the Layout of a Pipe having Large and Small Ends

Problem: Calculate the layout of a pipe having a nominal diameter of 6", length of 17-3/4", and fabricated from 20 gauge (.038) metal.

Procedure:

1. Find the circumference of the small end.

Circumference of small end = (nominal dia. x 11) + 3 x thickness
= 6 x 3.1416 = 18-7/8 + 3 x .038
= 18-7/8 + .114 = (18.989) or 19"-
= 18-7/8 + 3/32 = 19"-

If the answer contains a decimal, it will be necessary to change the decimal to a fraction.

To change a decimal to a fraction, multiply the decimal by the denominator of the desired fraction and place that denominator under the answer.

Example: Change .2423 to a fraction whose denominator is 16.

$$\begin{array}{r} .2423 \\ \times 16 \\ \hline 14538 \\ 2423 \\ \hline 3.8768 \end{array} \qquad \frac{3.8768}{16} = 4/16 = \frac{1}{4}$$

2. Find the circumference of the large end of pipe.
   Circumference of large end = circumference of small end plus seven times thickness of metal.
   Circumference of large end = 19 plus 7/32 = 19-7/32".

3. Draw the rectangle as illustrated by outer lines in Fig. 3. Proceed as follows:

   a. Draw centerline (℄) a-b.

   b. Mark off on the "A" end the circumference of the small end, (D_2-D_2) half on each side of the ℄.

   c. Lay out in same way on "B" end the circumference of the large end. D_1-D_1.

   d. Draw the lines D_1-D_2, connecting these points.

   e. The prescribed seam lap is then measured beyond lines D_1-D_2 and are drawn as L_1-L_2 .

   f. Notch small end to identify.

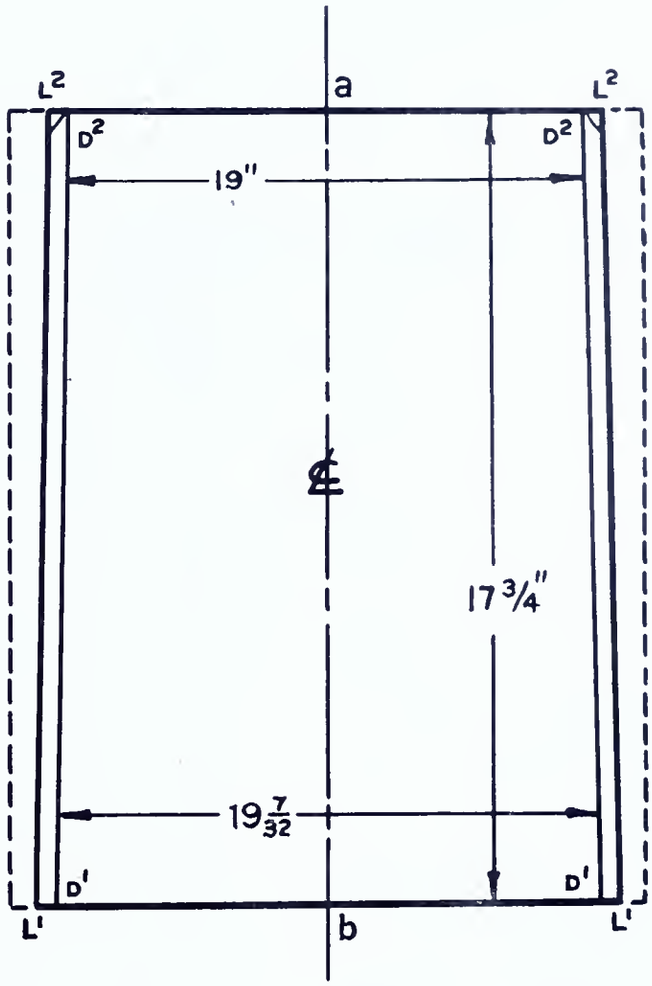


FIG. 3 PATTERN SKETCH

DESCRIPTION OF FLANGES

General Information:

Flanges are used to connect runs of pipe; they serve as a means of dividing longer sections, and simplify assembly of ventilation shapes aboard ship. Rubber or canvas gaskets may be specified between flanges, so that the joint will be fume-tight or water-tight. In making non-water-tight flanges, 16 gauge metal frequently is used.

The types of flanges generally used are: circular, flat oval, rectangular, and square. These are made as required by specifications.

CIRCULAR FLANGES

This type of flange is used to assemble round pipe and shapes. In making a round flange the inside diameter of the flange must be made approximately 1/16" larger than the outside diameter of the pipe, so that the flange may readily be placed over the end of the pipe.

Standard templates are made for flanges of different sizes thus permitting the interchangeability of flanged connections and flanges, owing to uniformity in sizes and layout of flange bolt holes.

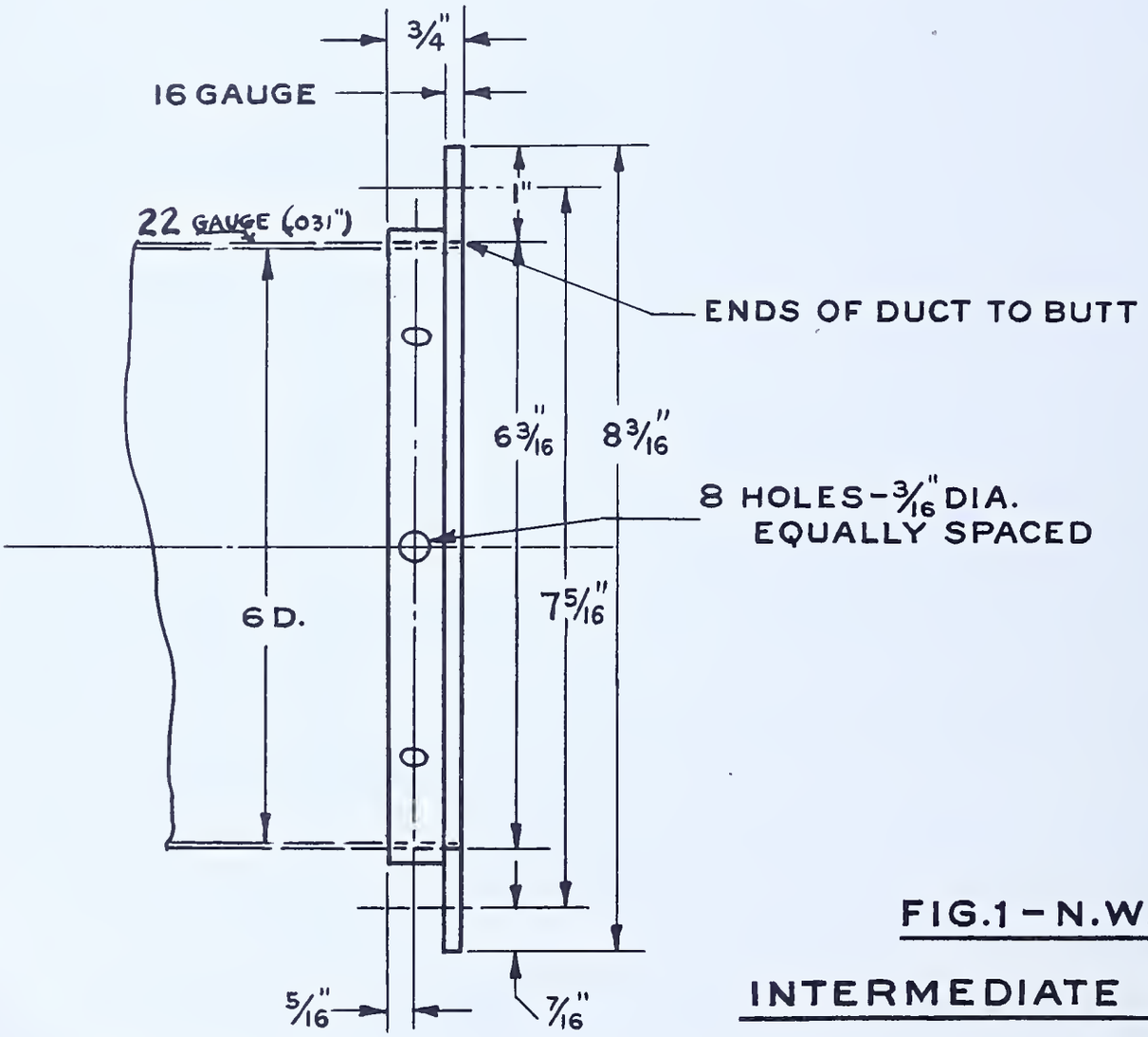


FIG.1 - N.W.T.

INTERMEDIATE FLANGE

DESCRIPTION OF FLANGES

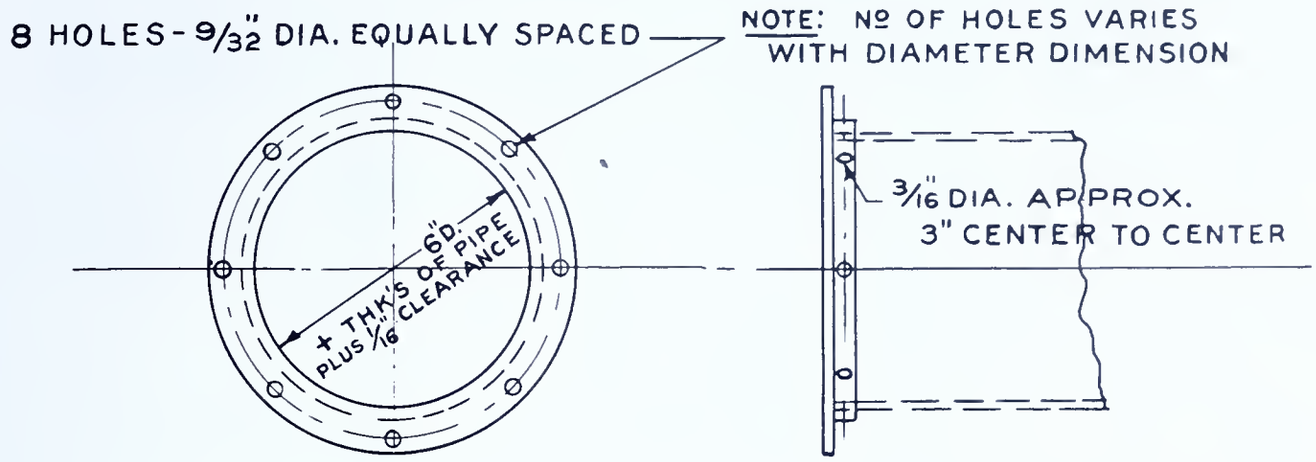

8 HOLES - 9/32" DIA. EQUALLY SPACED
NOTE: Nº OF HOLES VARIES WITH DIAMETER DIMENSION
6"D.
+ THK'S OF PIPE PLUS 1/16" CLEARANCE
3/16" DIA. APPROX.
3" CENTER TO CENTER

FIG. 2 — HOLE SPACING ON N.W.T. INTERMEDIATE CIRCULAR FLANGE

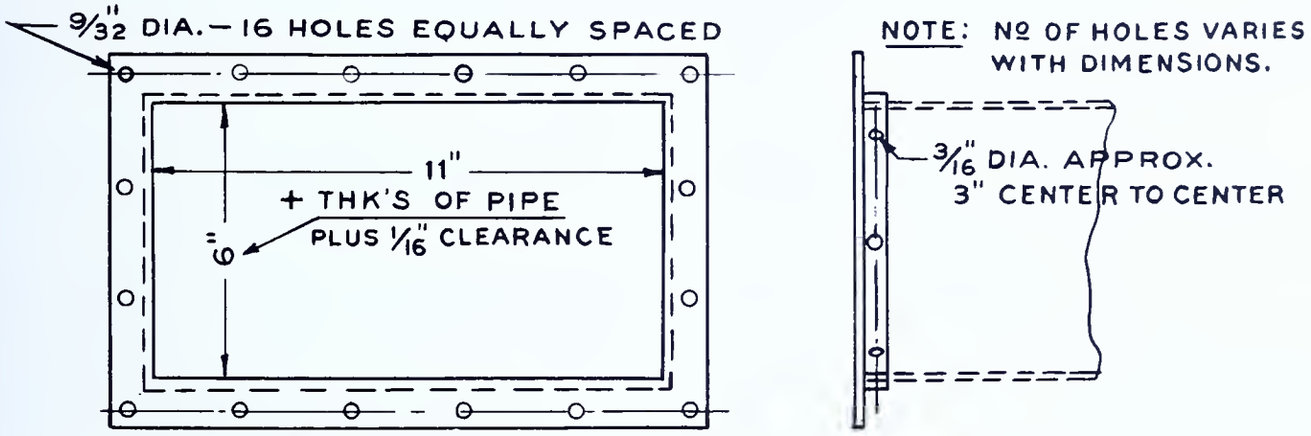

9/32" DIA. — 16 HOLES EQUALLY SPACED
11"
+ THK'S OF PIPE
PLUS 1/16" CLEARANCE
NOTE: Nº OF HOLES VARIES WITH DIMENSIONS.
3/16" DIA. APPROX.
3" CENTER TO CENTER

FIG. 3 - HOLE SPACING ON N.W.T. INTERMEDIATE RECT. FLANGE

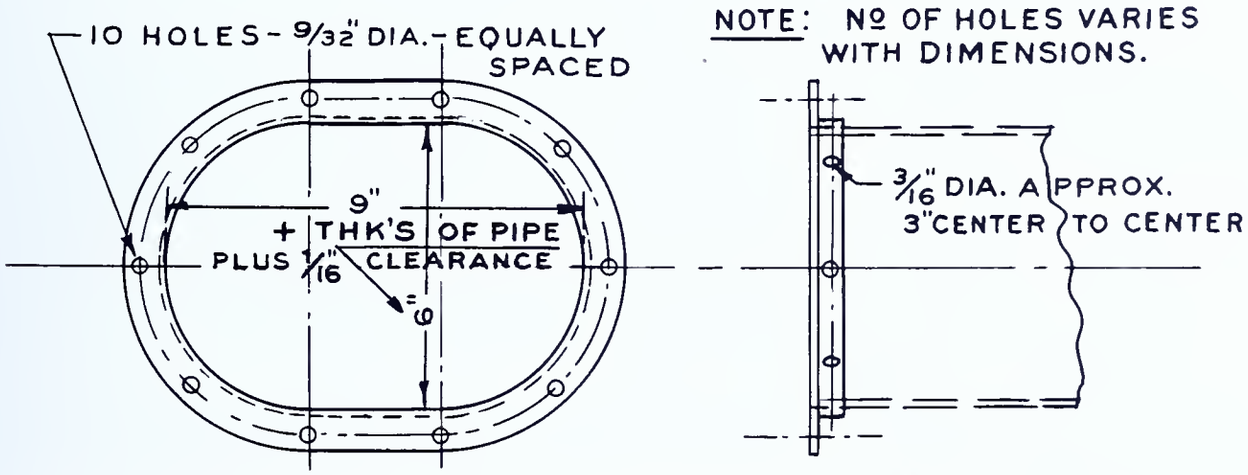

10 HOLES - 9/32" DIA. - EQUALLY SPACED
9"
+ THK'S OF PIPE
PLUS 1/16" CLEARANCE
NOTE: Nº OF HOLES VARIES WITH DIMENSIONS.
3/16" DIA. APPROX.
3" CENTER TO CENTER

FIG. 4 — HOLE SPACING ON N.W.T. INTERMEDIATE FLAT OVAL FLANGE

DESCRIPTION OF FLANGES

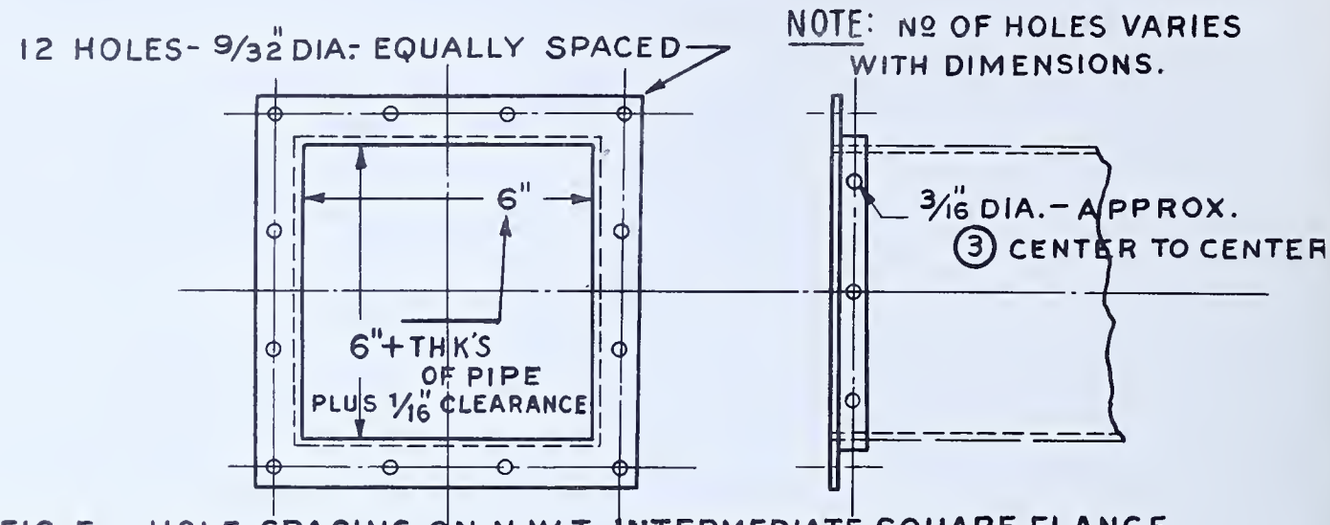

12 HOLES- 9/32" DIA: EQUALLY SPACED
NOTE: Nº OF HOLES VARIES WITH DIMENSIONS.
6"
6"+THK'S OF PIPE PLUS 1/16" CLEARANCE
3/16 DIA.- APPROX. (3) CENTER TO CENTER

FIG. 5 – HOLE SPACING ON N.W.T. INTERMEDIATE SQUARE FLANGE

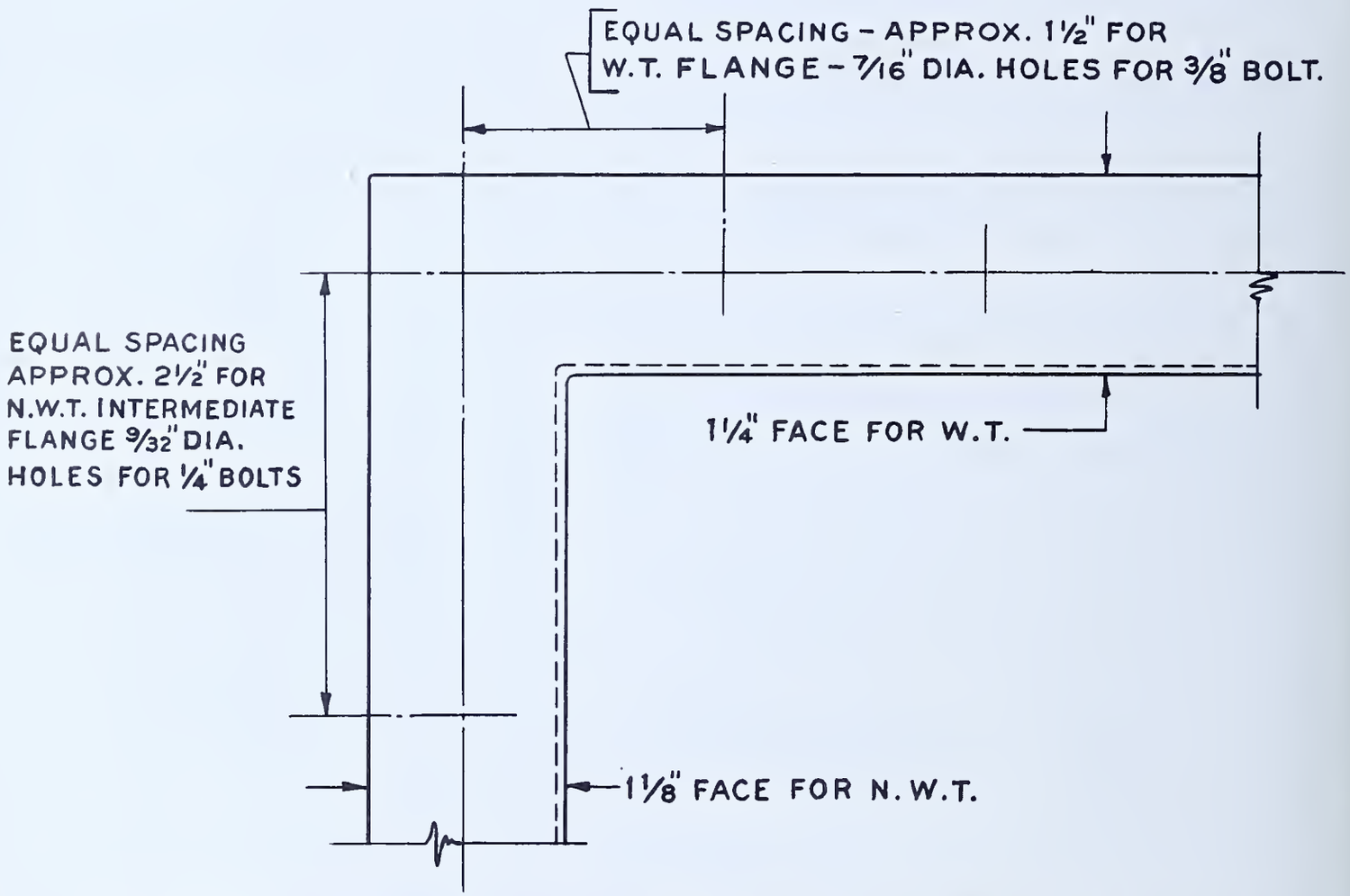
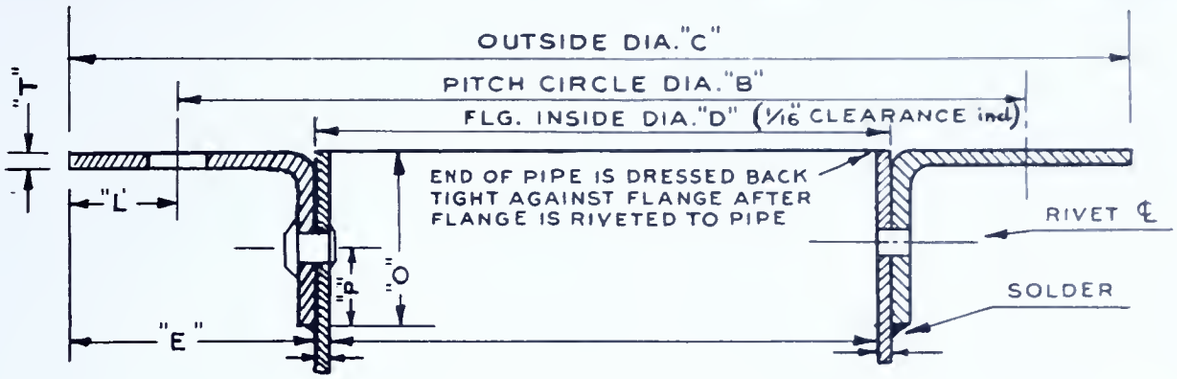

EQUAL SPACING - APPROX. 1½" FOR W.T. FLANGE - 7/16" DIA. HOLES FOR 3/8" BOLT.
EQUAL SPACING APPROX. 2½" FOR N.W.T. INTERMEDIATE FLANGE 9/32" DIA. HOLES FOR ¼" BOLTS
1¼" FACE FOR W.T.
1⅛" FACE FOR N.W.T.

FIG. 6 – GENERAL INFORMATION FOR RECTANGULAR FLANGES



N.W.T. INTERMEDIATE FLANGE

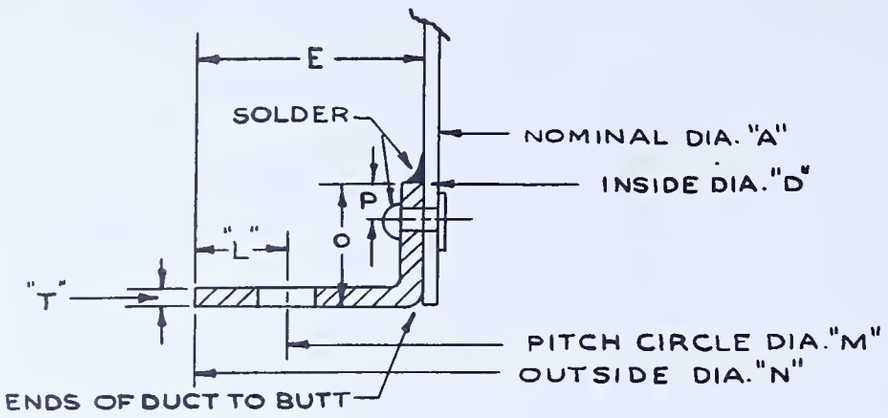
TABLE OF SIZES

Nom. Dia. "A"	These Figures Include 1/16" Clearance			"E"	"O"	"P"	"L"	THICKNESS "T"		Size of Bolts or Screw	No. of Bolts or Screw	No. of Riv.	Size of Riv.
	P.C. Dia. in Inches "B"	Out-side Dia. in Inches "C"	In-side Dia. in Inches "D"					Inches	Gauge				
2½	3 13/16	4 11/16	2 11/16	1"	3/4"	5/16"	7/16"	.063	#16 USS		6	4	4 lb.
3	4 5/16	5 3/16	3 3/16								6	4	
3½	4 13/16	5 11/16	3 11/16								6	4	
4	5 5/16	6 3/16	4 3/16								6	6	
4½	5 13/16	6 11/16	4 11/16								8	6	
5	6 5/16	7 3/16	5 3/16								8	6	
5½	6 13/16	7 11/16	5 11/16								8	6	
6	7 5/16	8 3/16	6 3/16								8	8	
6½	7 13/16	8 11/16	6 11/16					.078	#14 USS		10	8	5 lb.
7	8 5/16	9 3/16	7 3/16								10	8	
7½	8 13/16	9 11/16	7 11/16								10	8	
8	9 5/16	10 3/16	8 3/16								10	10	
9	10 5/16	11 3/16	9 3/16								12	10	
10	11 5/16	12 3/16	10 3/16								12	12	
11	12 5/16	13 3/16	11 3/16								14	12	
12	13 5/16	14 3/16	12 3/16								14	14	

(Size of Bolts or Screw: ¼"-20 Machine Screws)

N.W.T. (Intermediate) FLANGES - STEEL

Mechanic will have to check diameter with reference to gauge of metal used. This chart based on pipe of 16 gauge (.0625).



N.W.T. – TO – W.T. FLANGES – STEEL

TABLE OF SIZES

Nom. Dia. "A"	These Figures Include 1/16" Clearance: P.C. Dia. "M"	Outside Dia. "N"	Inside Dia. "D"	"E"	"O"	"P"	"L"	"T" THICKNESS: inches	gauge	No. of Bolts	Size of Bolts	No. of Riv.	Size of Riv.
2½	4 5/16	5 3/8	2 11/16	1 9/32	3/4	5/16	17/32	.063	#16	8	3/8	4	4 lb.
3	4 13/16	5 7/8	3 3/16							8		4	
3½	5 5/16	6 3/8	3 11/16							10		6	
4	5 13/16	6 7/8	4 3/16							10		6	
4½	6 5/16	7 3/8	4 11/16							12		6	
5	6 13/16	7 7/8	5 3/16							12		6	
5½	7 5/16	8 3/8	5 11/16							14		6	
6	7 13/16	8 7/8	6 3/16							14		8	
6½	8 5/16	9 3/8	6 11/16					.078	#14	16		8	5 lb.
7	8 13/16	9 7/8	7 3/16							16		8	
7½	9 5/16	10 3/8	7 11/16							18		10	
8	9 13/16	10 7/8	8 3/16							18		10	
9	10 13/16	11 7/8	9 3/16							20		10	5 lb.
10	11 13/16	12 7/8	10 3/16							24		12	
11	12 13/16	13 7/8	11 3/16							26		12	
12	13 13/16	14 7/8	12 3/16							28		14	

FIG. 8 N.W.T. - TO - W.T. FLANGES - STEEL

Mechanic will have to check diameter with reference to gauge of metal used. This chart based on 16 gauge (.0625).

SKETCHES FOR W.T. FLANGES

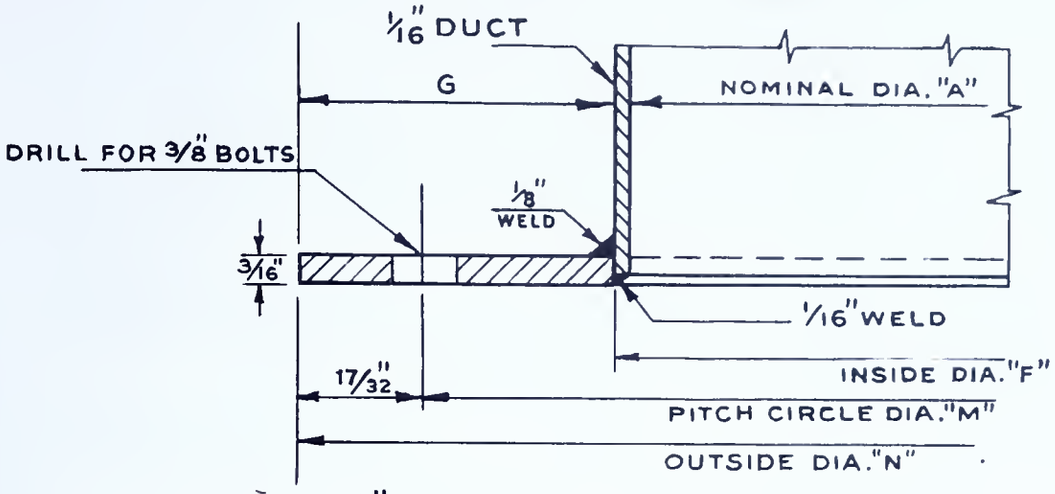


FIG. 9 FLANGE 1/16" ROUND W.T. DUCT ONLY

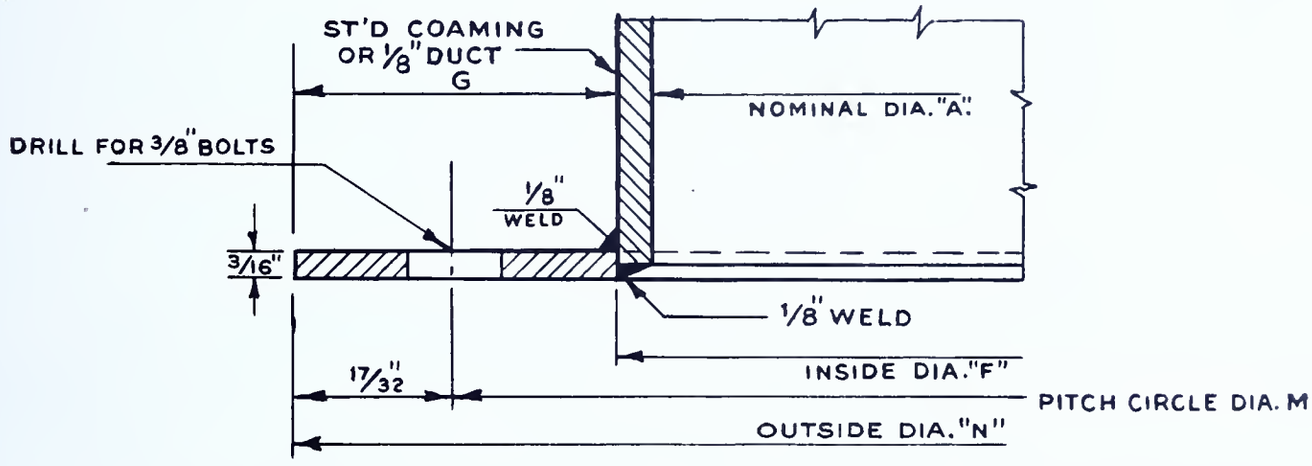


FIG. 10 FLANGE FOR ST'D COAMING OR 1/8" W.T. ROUND DUCT AND RECT., OR FLAT OVAL DUCTS NOT OVER 24" WIDE FLAT SURFACE

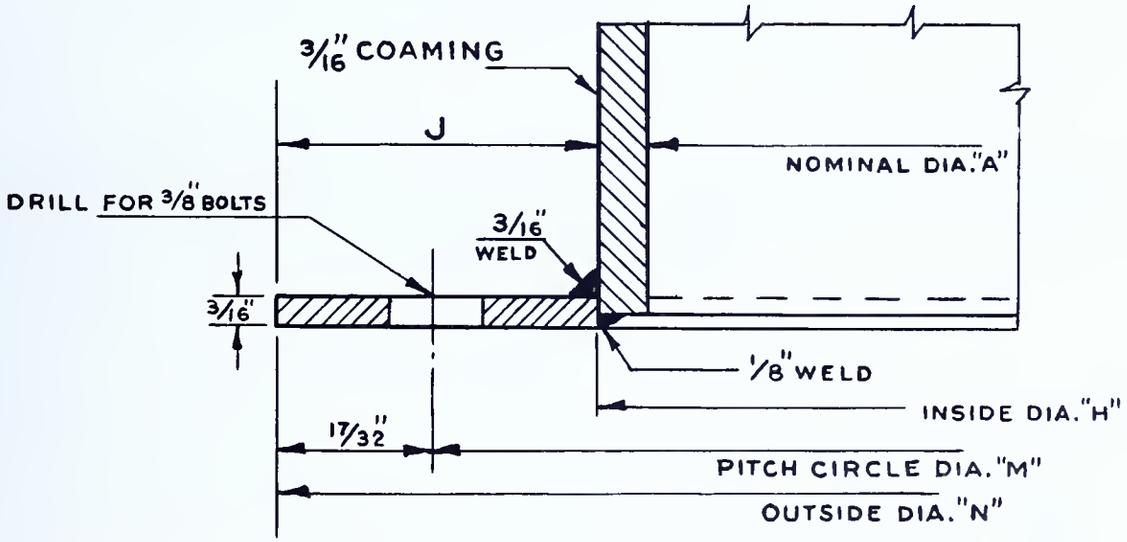


FIG. 11 FLANGE FOR ALL 3/16" COAMINGS

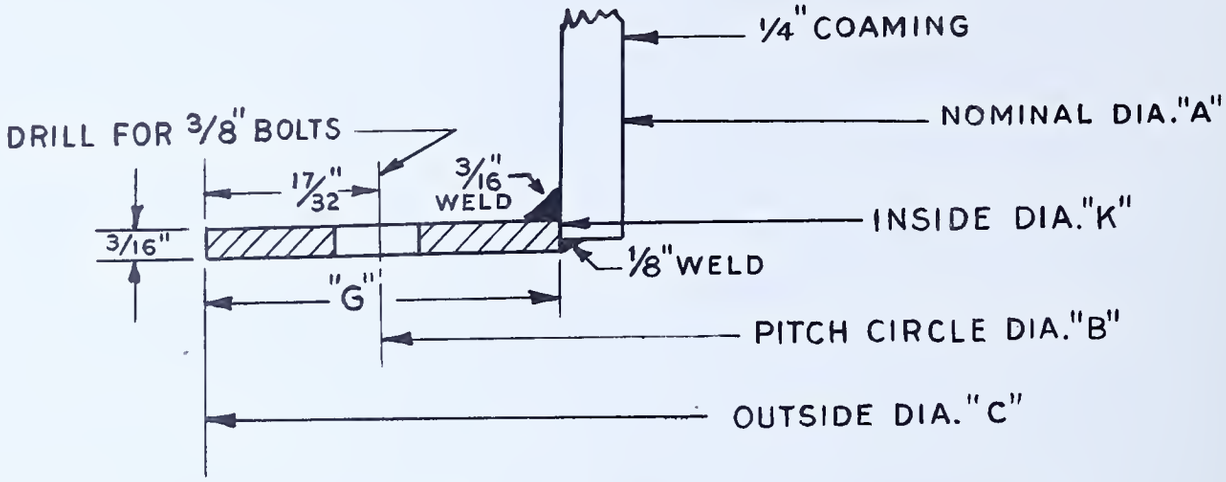


FIG 12. FLANGE FOR ALL W.T. 1/4" COAMINGS

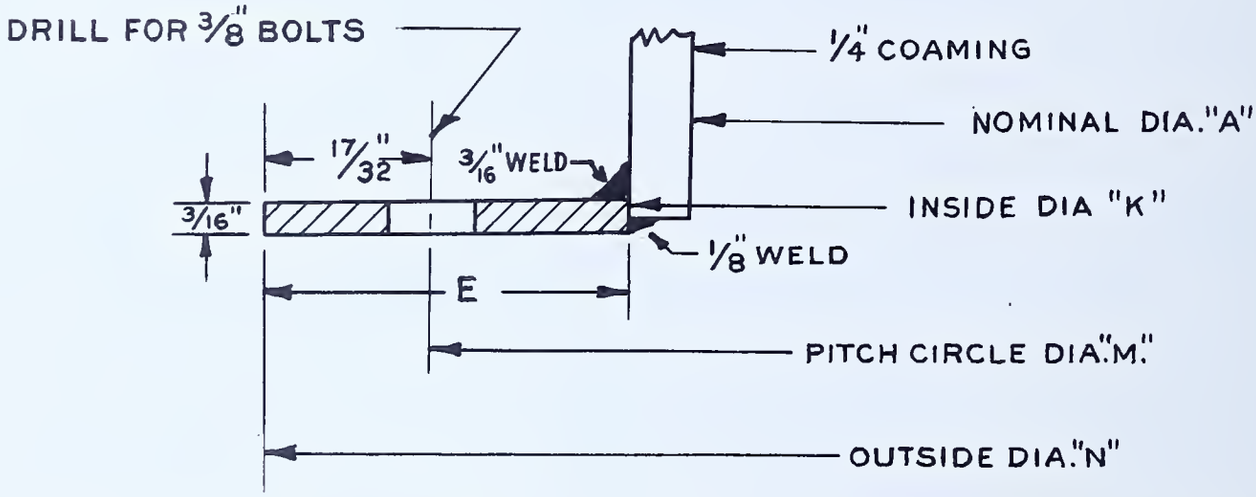


FIG 13. N.W.T. FLANGE FOR 1/4" PLATE SPOOL THRU GIRDERS AND WEB FRAMES

TABLE OF SIZES

Nom. Dia. "A"	P.C. Dia. "M" *	Outside Dia. "N" *	P.C. Dia. "B" *	Outside Dia. "C" *	"E"	Inside Dia. "F" *	"G"	Inside Dia. "H" *	"J"	Inside Dia. "K" *	No. of Bolts Sketch 1-2-3-7	No. of Bolts Sketch 4
2½	4 3/16	5 1/4	4 7/16	5½	1 1/8	2 3/4	1¼	2 7/8	1 3/16	3	8	8
3	4 11/16	5 3/4	4 15/16	6	↓	3 1/4	↓	3 3/8	↓	3½	8	10
3½	5 3/16	6 1/4	5 7/16	6½		3 3/4		3 7/8		4	10	10
4	5 11/16	6 3/4	5 15/16	7		4 1/4		4 3/8		4½	10	12
4½	6 3/16	7 1/4	6 7/16	7½		4 3/4		4 7/8		5	12	12
5	6 11/16	7 3/4	6 15/16	8		5 1/4		5 3/8		5½	12	14
5½	7 3/16	8 1/4	7 7/16	8½		5 3/4		5 7/8		6	14	14
6	7 11/16	8 3/4	7 15/16	9		6 1/4		6 3/8		6½	14	16
6½	8 3/16	9 1/4	8 7/16	9½		6 3/4		6 7/8		7	16	16
7	8 11/16	9 3/4	8 15/16	10		7 1/4		7 3/8		7½	16	18
7½	9 3/16	10 1/4	9 7/16	10½		7 3/4		7 7/8		8	18	18
8	9 11/16	10 3/4	9 15/16	11		8 1/4		8 3/8		8½	18	20
9	10 11/16	11 3/4	10 15/16	12		9 1/4		9 3/8		9½	20	22
10	11 11/16	12 3/4	11 15/16	13		10 1/4		10 3/8		10	24	24
11	12 11/16	13 3/4	12 15/16	14		11 1/4		11 3/8		11½	26	26
12	13 11/16	14 3/4	13 15/16	15		12 1/4		12 3/8		12½	28	28

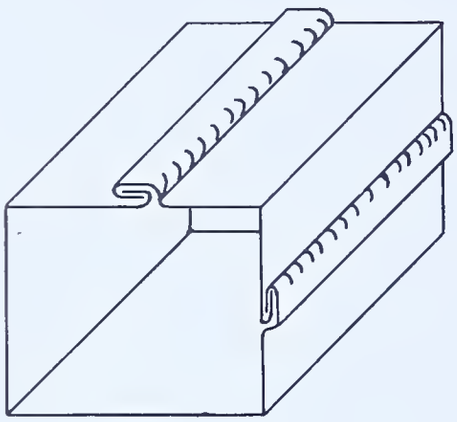
*Add 1/16" clearance.

W.T. FLANGES - STEEL

Inside flange measurements depend upon thickness of pipe.
Thickness of pipe + 1/16" clearance + nominal diameter.

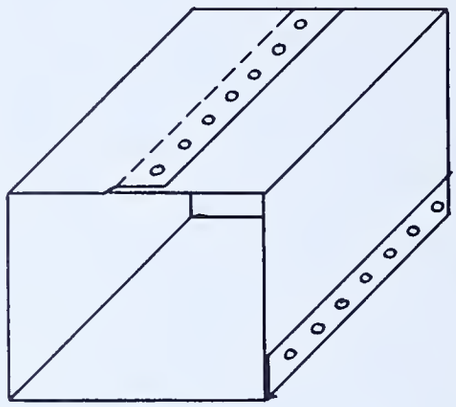
DESCRIPTION OF RECTANGULAR PIPE SEAMS

General:
The method used in seaming any pipe together is determined from the specifications. Any one or combination of seams may be specified.



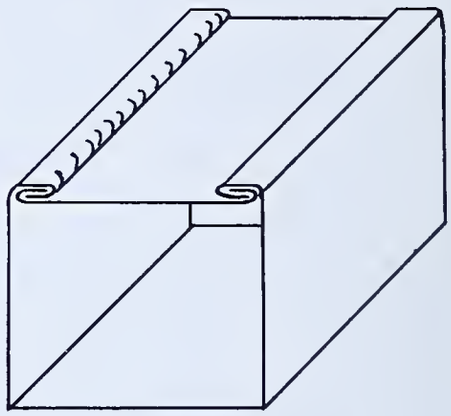
GROOVED

ONE OR MORE SEAMS MAY BE USED. SEAMS MUST BE PLACED ON SIDES, AWAY FROM CORNERS.



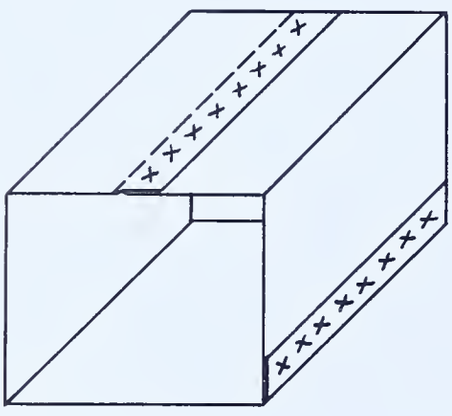
RIVETED

ONE OR MORE SEAMS MAY BE USED. SEAMS MAY BE LOCATED ON SIDES OR AT CORNERS.



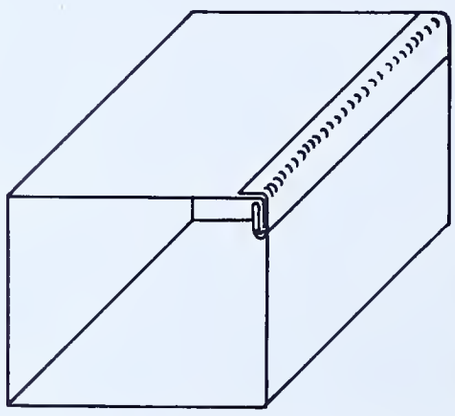
DOUBLE SEAMED

ONE OR MORE SEAMS MAY BE USED, SEAMS MUST BE PLACED ON CORNERS.



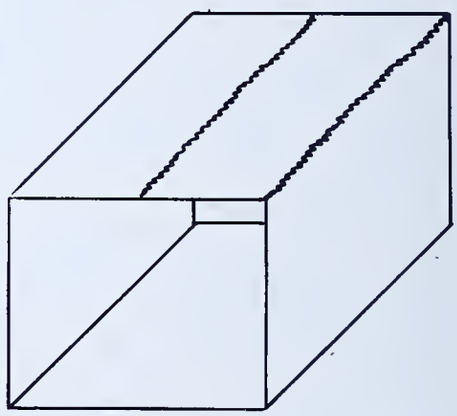
SPOT WELDED

ONE OR MORE SEAMS MAY BE USED, SEAMS MAY BE LOCATED ON SIDES OR AT CORNERS.



PITTSBURGH LOCK

ONE OR MORE SEAMS MAY BE USED. SEAMS MUST BE LOCATED ON THE CORNERS.



WELDED

ONE OR MORE SEAMS MAY BE GAS OR ARC WELDED. SEAMS MAY BE LOCATED ON SIDES OR AT CORNERS.

DOUBLE SEAMING

General Information:

In marine sheet metal practice, double seaming is sometimes used in the fabrication of shapes, the pieces of which meet at or near a right angle, as shown in Fig. 1. Double seaming is not usually used in the fabrication of shapes that are made from sheet metal heavier than 20 gauge (.037).

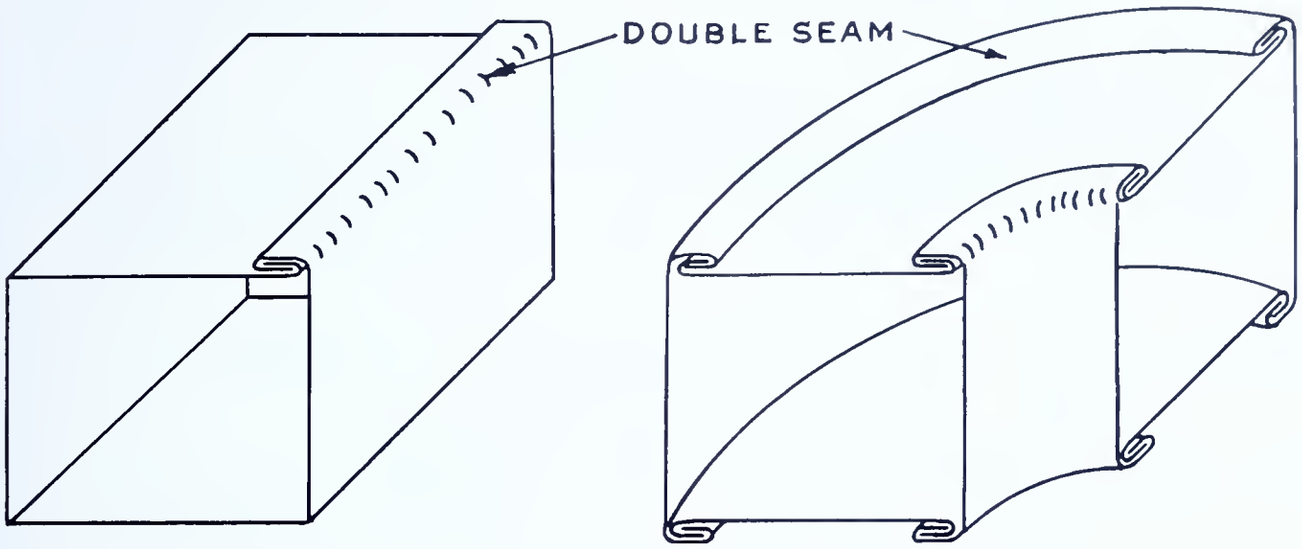


FIG. 1 — APPLICATIONS OF DOUBLE SEAMING

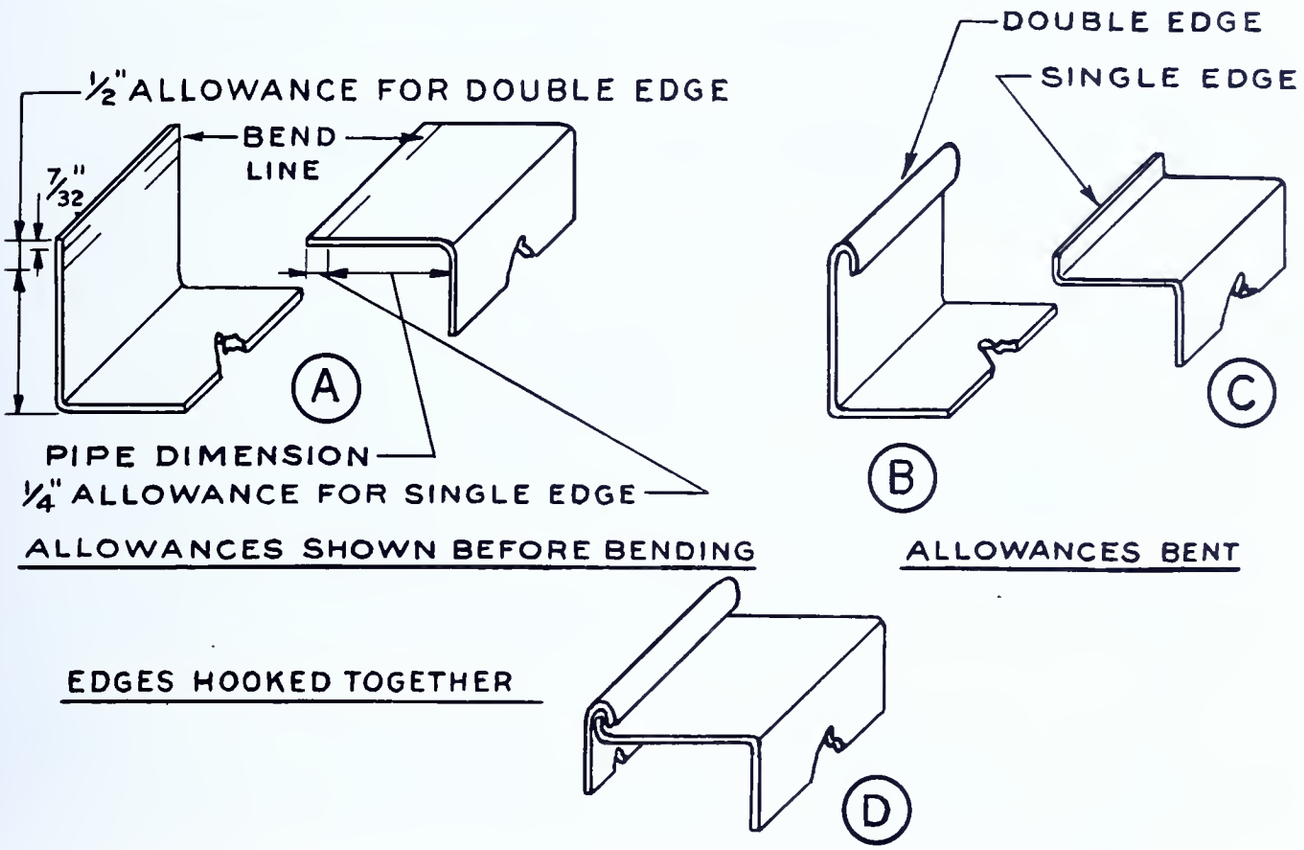
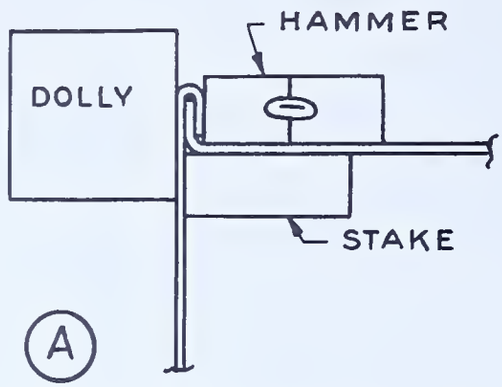
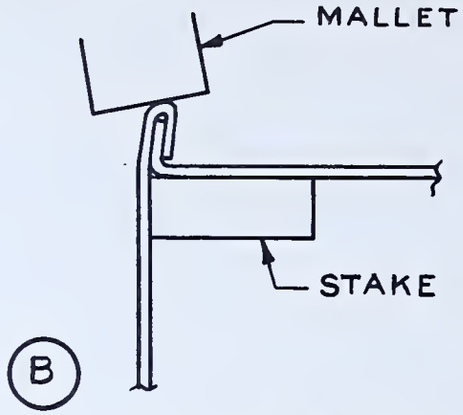


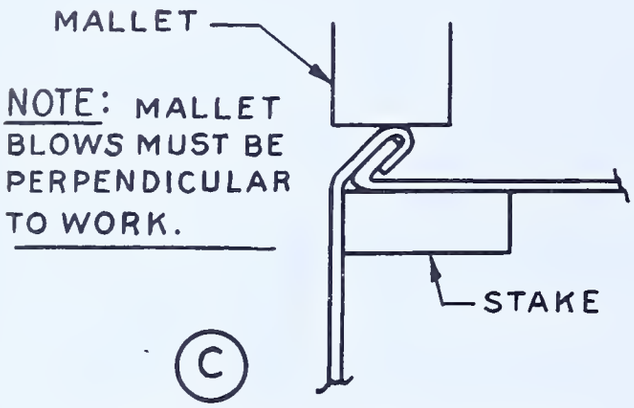
FIG. 2 — ALLOWANCES FOR DOUBLE SEAMING



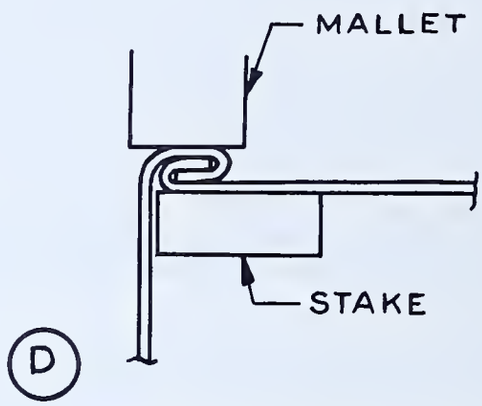
FLATTEN HOOKED EDGES.



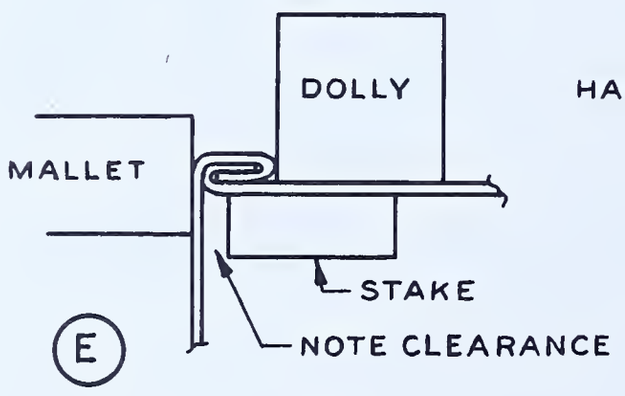
STEP ONE IN KNOCKING DOWN SEAM.



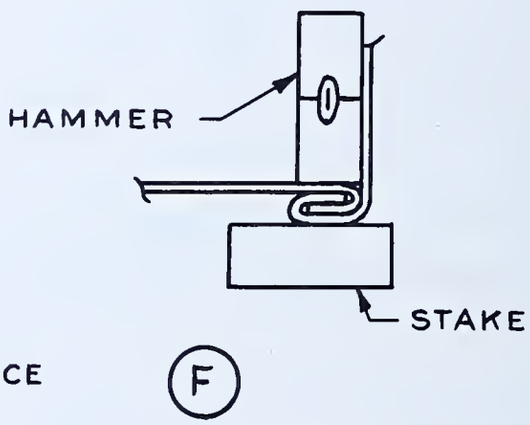
STEP TWO IN KNOCKING DOWN SEAM.



SEAM KNOCKED DOWN.



DRESS UP SEAM.



FLATTEN SEAM WITH HAMMER.

FIG. 3 — OPERATIONS FOR DOUBLE SEAMING

HOW TO DOUBLE SEAM

Procedure:

1. Lay out allowances and bend lines on the metal. Fig. 2 (A). Page 147.

2. Brake the single edge. Fig. 2 (C).

3. Brake the double edge. Fig. 2 (B).

4. Hook single and double edges together. Fig. 2 (D).

5. Using a hammer and dolly close double edge tightly against single edge. Fig. 3 (A). Page 148.

6. Using a mallet, knock down seam.
   The direction of the mallet blow should be inclined slightly toward the direction of the desired bend. Fig. 3 (B).
   After starting bend with mallet in a slightly inclined position, the bend is completed with the mallet in a vertical position. Fig. 3 (C) and (D).

7. Using a dolly and mallet "dress up" double seam. Fig. 3 (E).
   In knocking down the seam, the seam tends to become round, or out-of-square. "Dressing up" is necessary to re-shape the seam.

8. Tighten the seam by "dressing up" from the inside. Fig. 3 (F).
   If it is impossible to use a hammer on the inside of the shape, it will be necessary to place the work on a stake and "dress up" the seam from the outside.

General Note:
The dimensions shown in Fig. 2, "Allowances for Double Seaming", are standard. However, they may be varied according to specifications. Fig. 4 shows a rule which must be followed when double seaming is used to join sheet metal. If this is overlooked, the seam will come apart when the knocking down operation is completed.

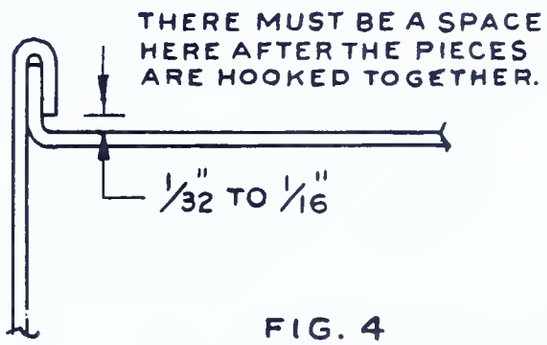


FIG. 4
CLEARANCE DIMENSION

Problem:

Make sketch for the pattern of a double seamed rectangular pipe 6" x 6" x 12" long. Indicate all bend lines and mark all dimensions.

PITTSBURGH LOCK SEAM

General Information:

Two principal advantages of the Pittsburgh lock seam are:

a. Less skill and time are required to assemble pipe and fittings.
b. Work can be shipped "knocked down" to the point of installation.

Lay Out Allowances:

The size of the Pittsburgh seam is determined by the way in which it is made. If made on the lock former it will be of the dimensions shown in Fig. 1. If made on the hand brake, it will be of the dimensions shown in Figs. 1, 2, and 3.

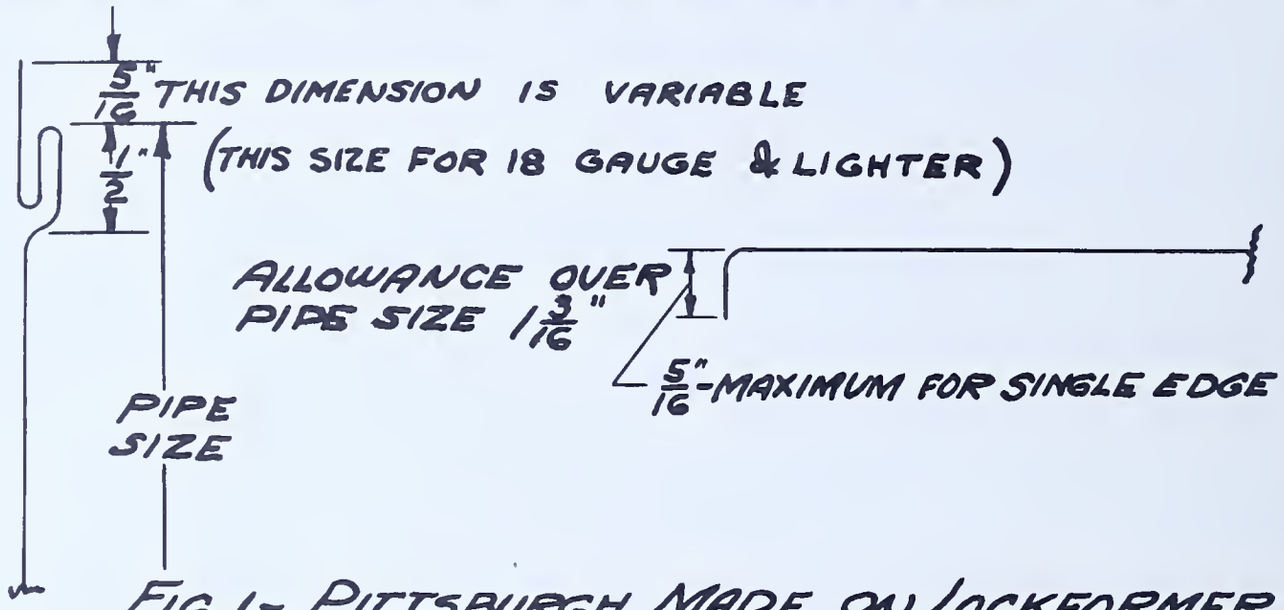

5/16" THIS DIMENSION IS VARIABLE
1/2"
(THIS SIZE FOR 18 GAUGE & LIGHTER)
ALLOWANCE OVER PIPE SIZE 1 3/16"
5/16"-MAXIMUM FOR SINGLE EDGE
PIPE SIZE

FIG. 1- PITTSBURGH MADE ON LOCKFORMER

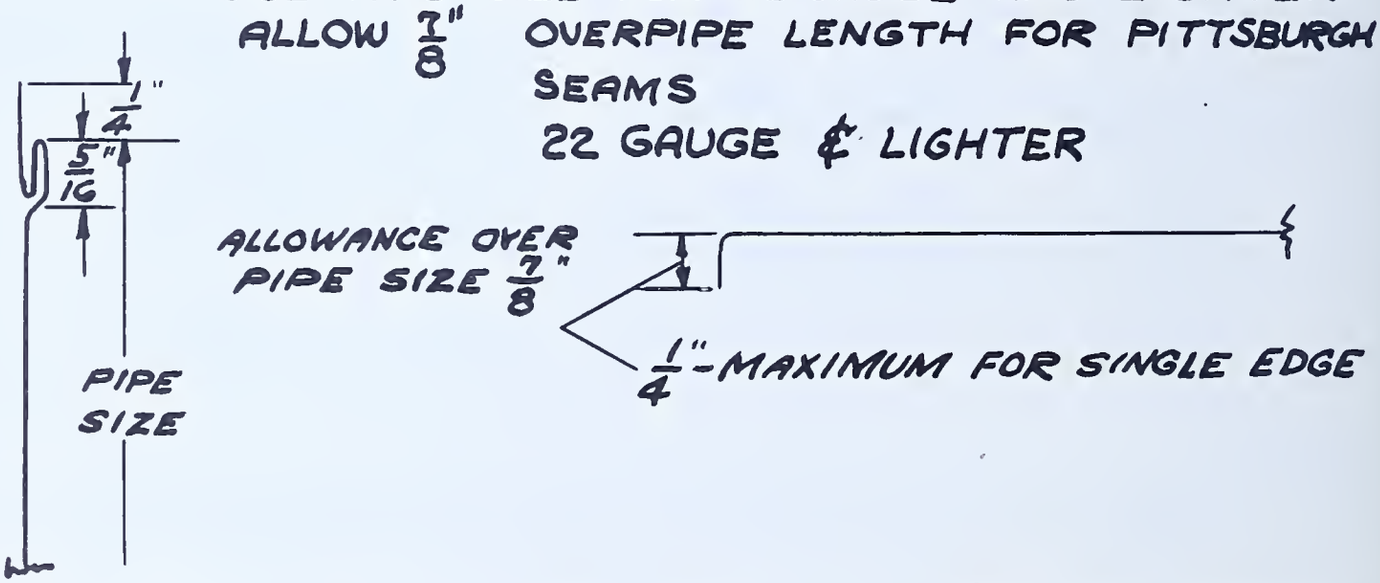

USE THIS SIZE FOR 22 GAUGE AND LIGHTER
ALLOW 7/8" OVERPIPE LENGTH FOR PITTSBURGH SEAMS
22 GAUGE & LIGHTER
1/4"
5/16"
ALLOWANCE OVER PIPE SIZE 7/8"
1/4"-MAXIMUM FOR SINGLE EDGE
PIPE SIZE

FIG. 2-SMALL PITTSBURGH MADE ON CORNICE BRAKE

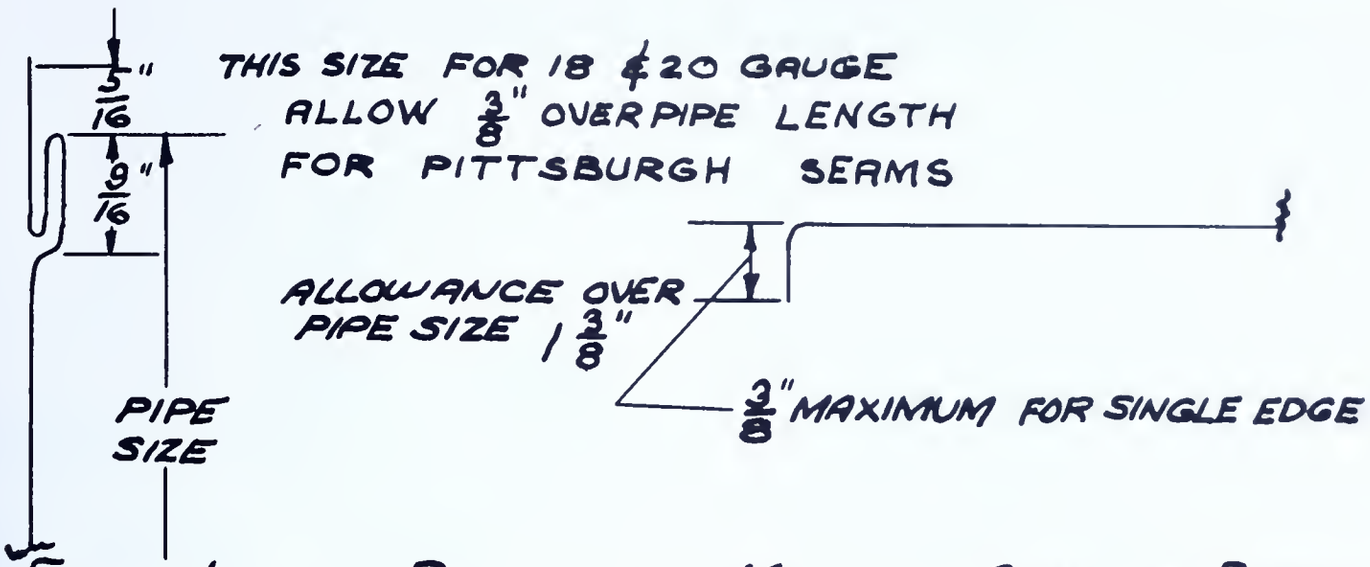


FIG. 3 – LARGE PITTSBURGH MADE ON CORNICE BRAKE

Assembly Procedure:

1. Insert single edge into lock.

2. Hold metal tightly together at end of pipe ("a", Fig. 4) with a pair of pliers. With a mallet knock down about two inches of the lock. In the same way knock down about two inches of the lock on the other end of the pipe. This will hold the single edge in place for its entire length.

3. Finish knocking down the remainder of the lock.

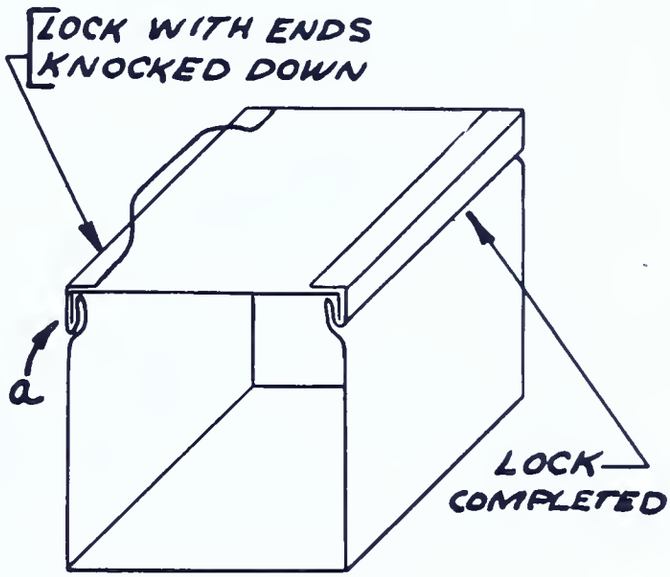


FIG. 4

PROCEDURE IN FINISHING

TURNING A DOUBLE EDGE WITH A TURNING MACHINE

1. Set the gauge (Fig. 1) about 1/16" back from the shoulder on the lower roll by turning the knurled adjustment screw.

2. Lock the gauge in place with the knurled lock nut.

3. Holding the collar in the left hand, place the edge to be turned between the rolls and against the gauge. (Fig. 2)

4. Bring down the upper roll by turning the crankscrew with the right hand until the metal is held firmly between the rolls.

5. Hold the edge of the job being turned against the gauge with the left hand and turn the operating handle with the right hand, allowing the job to revolve between the thumb and fingers. (Fig. 2)

6. Continue turning until job has progressed through the steps shown in Fig. 3.

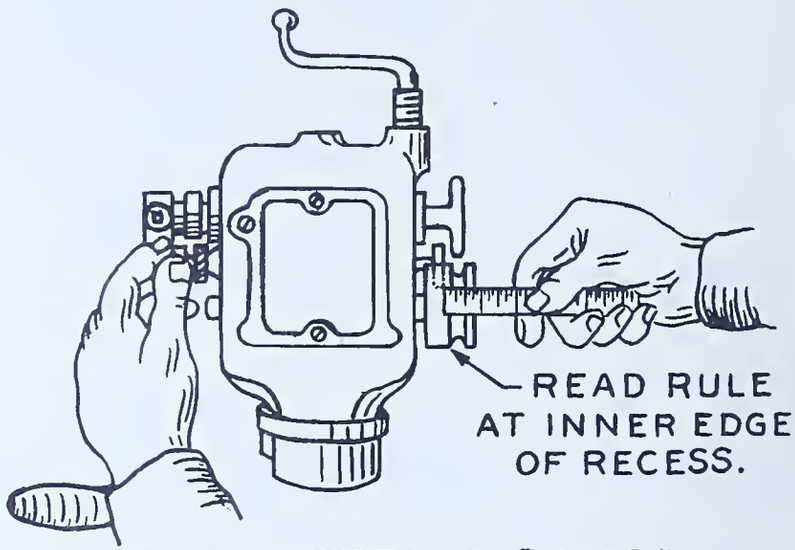


FIG. 1 — SETTING GAUGE

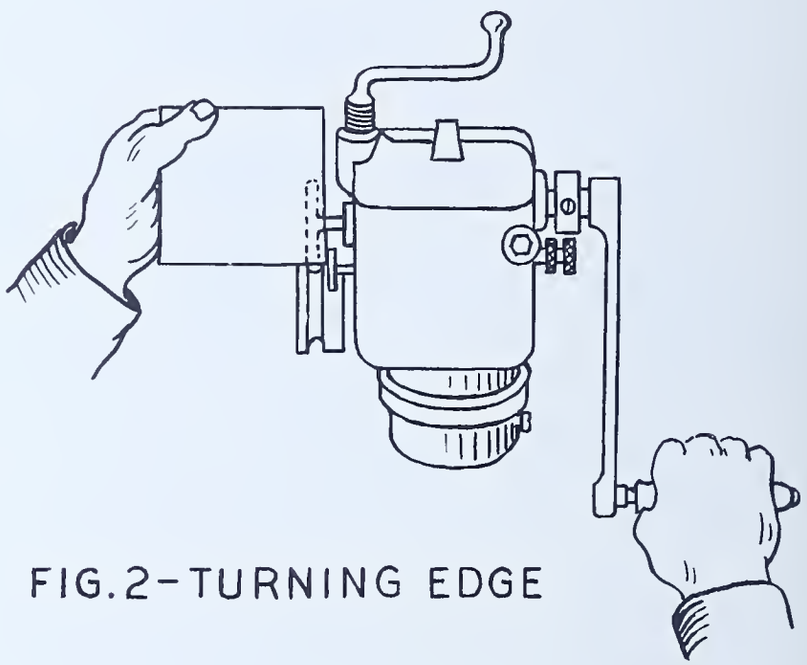
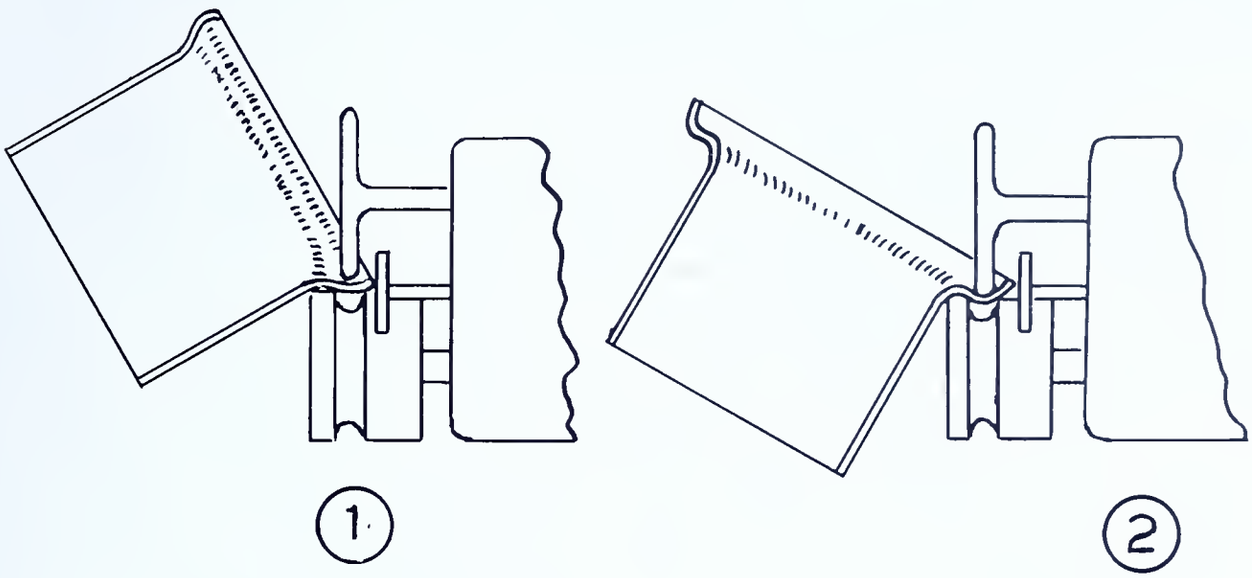


FIG. 2 — TURNING EDGE

Note: Turn the job through several revolutions for each step shown. Should the job get out of shape, it will be necessary to take it from between the rolls and round it up before proceeding with the next step.



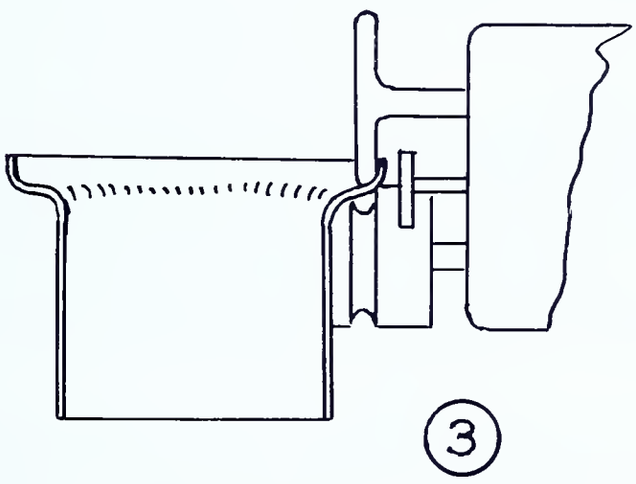


FIG. 3 — STEPS IN TURNING "DOUBLE EDGE"

ELECTRIC SPOT WELDING

Two or more thicknesses of sheet metal may be fastened together by spot welding. This method is similar in effect to riveting, since the weld spots are about the same diameter as a rivet and are spaced along seams the same as rivets. Fig. 1. Spot welding is replacing riveting because considerably less time is required to fabricate a spot welded job.

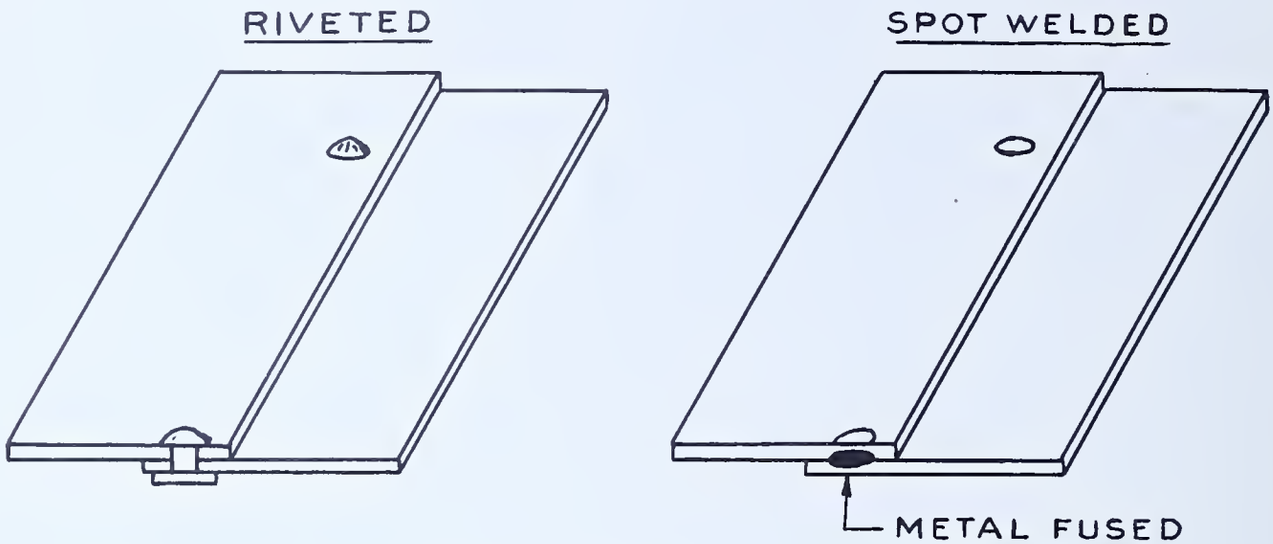


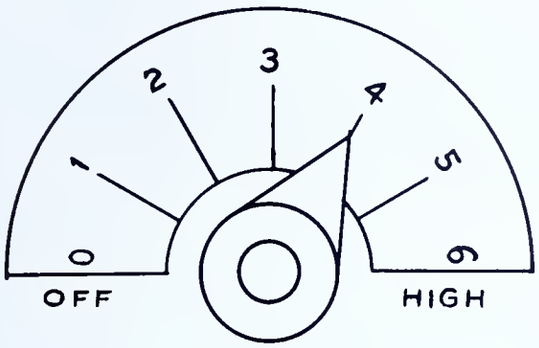
FIG. 1 - RIVETS & SPOT WELDS

HEAT AND TIME REGULATION FOR SPOT WELDING

In spot welding, different thicknesses require different heats and time. "Heat" is the shop word for "volume" of electricity. "Time" is the shop word denoting the length of time that the metal is allowed to resist a specific "volume" of electricity. The thinner the metal the less heat and time required to make a satisfactory weld.

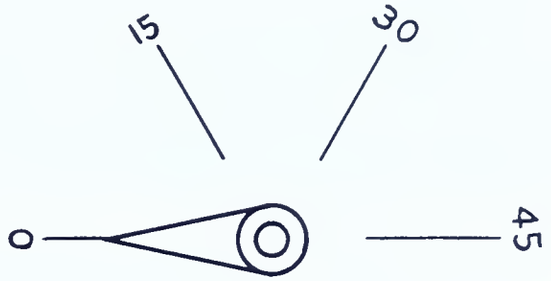
Note: When setting the heat and time controls, Fig. 2, keep both at a minimum and gradually increase them until a satisfactory weld is obtained. If the heat and time are set to more than that which is required, the metal will splatter out from the weld, striking the operator. This may cause serious burns.

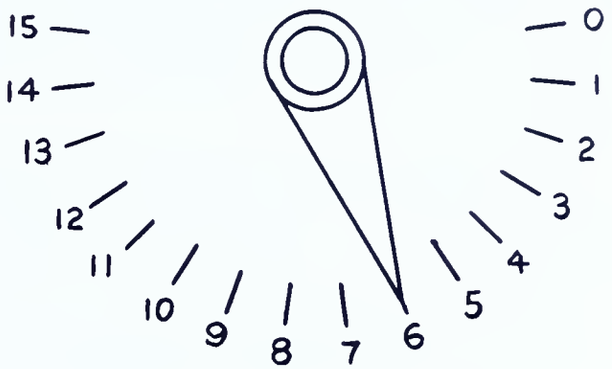
Caution: Always wear goggles when operating the spot welder. If the operator wears eye glasses, he should wear a pair of goggles over them, since specks of molten metal striking his eye glasses would embed themselves into the lenses, thereby ruining the glasses.



HEAT CONTROL

READING SHOWN - 4
MINIMUM - 1
MAXIMUM - 6 (HIGH)





TIME-CYCLES

READING SHOWN - 6 CYCLES
MINIMUM - 1 CYCLE
MAXIMUM - 60 CYCLES

FIG. 2 HEAT & TIME

HOW TO MAKE A SPOT WELD

Before attempting to make a spot weld, read the parts of this series entitled "Electric Spot Welding", "Heat and Time Regulation for Spot Welding", and "Test Welds". References K and M.

General Information:

All spot welders are not automatically timed. The ones that are not automatically timed depend upon the operator to regulate the length of time that the circuit remains closed. Misjudgment of time results in inferior welds which in turn cause job failure.

In some cases it will be necessary to change the position of the dies to weld in places which are not accessible to straight die "set ups". Special dies may be designed and "made up" to weld places which can not be reached with common standard dies.

When spot welding black iron, the scale should be removed for best results.

Since the zinc coating is burned away during the spot welding of galvanized iron, it will be necessary to paint welded spots to prevent rusting.

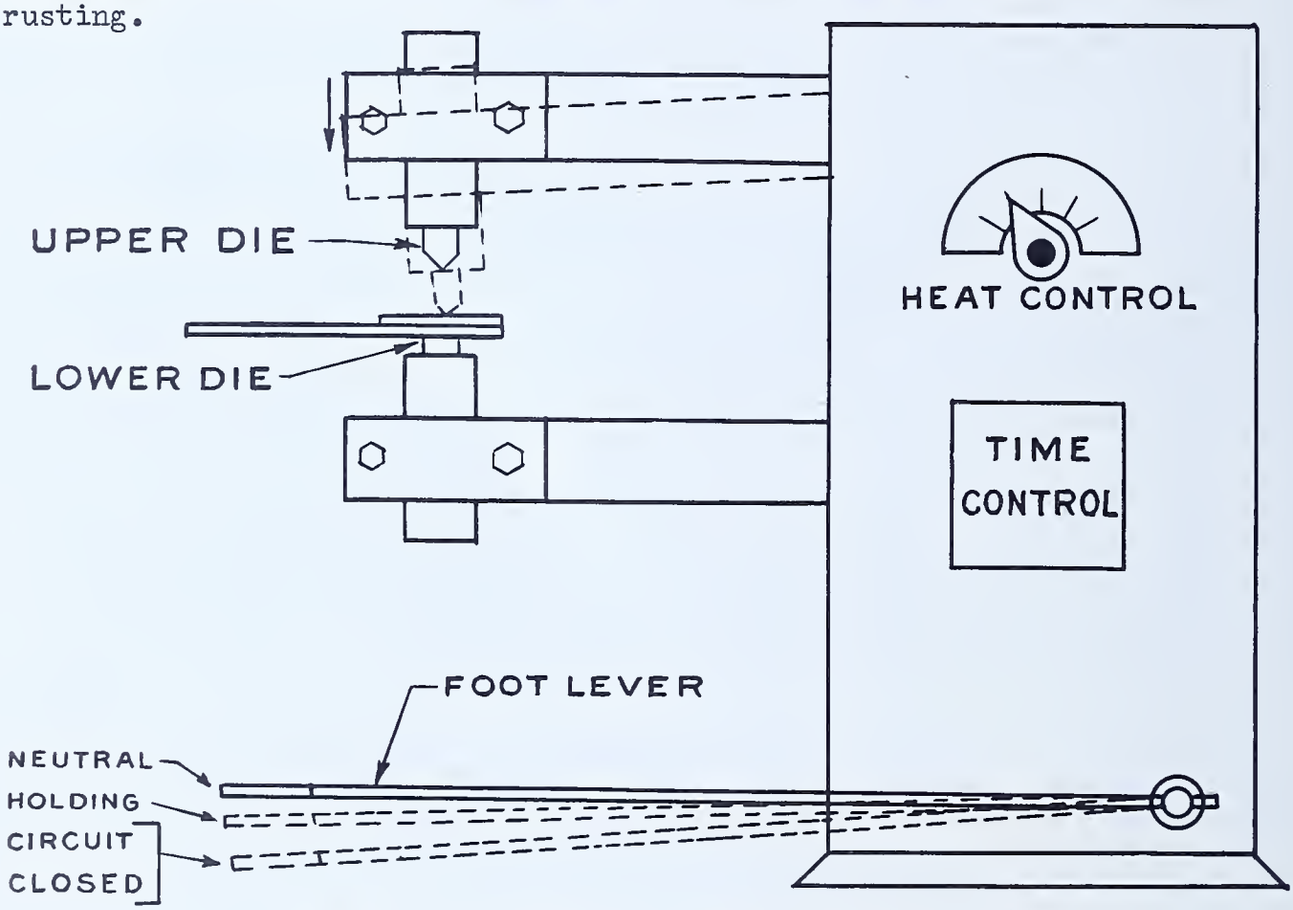


FIG. 1 — SPOT WELDING MACHINE

Procedure:

1. Place the metal between the copper dies of the machine so that the spot to be welded is approximately under the center of the upper die. Let the bottom piece of metal rest on the lower die. Fig. 1.

2. Step on foot lever, pressing it down slowly. The first part of the "travel" will bring down the upper die, holding the metal tightly between the dies.

3. Continue pressing down on the foot lever. This will close the electric circuit.

   Note: Do not move your feet hurriedly from the lever but keep the pressure applied until the buzzing noise stops. The circuit is closed by the operator, but it is broken automatically by the timer so that it does not make any difference how long the operator keeps the foot lever in the "circuit closed" position.

4. Remove the pressure from the foot lever and allow the dies to open.

5. Move metal so that the next spot to be welded is between the dies and repeat procedures 2, 3, and 4 until the desired number of welds have been completed.

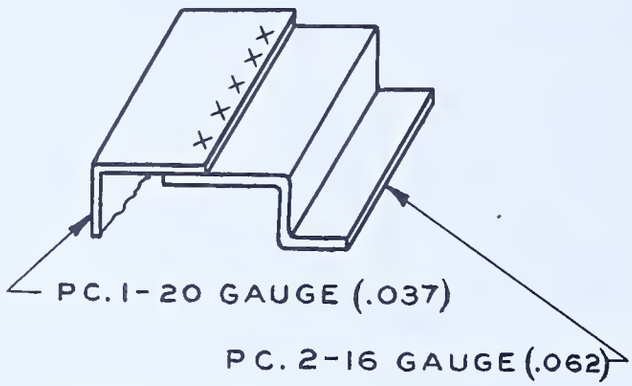
HOW TO MAKE A TEST WELD

General Information:

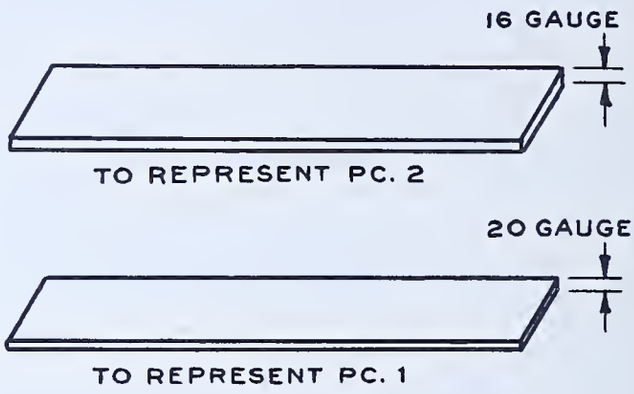
When two or more pieces of sheet metal are to be joined together by spot welding, it is necessary that the operator know whether the weld is "holding". To determine this a sample weld is first made and tested.

Procedure:

1. Secure specimen pieces, approximately 1" x 6" of the metal to be welded. See Fig. 1.



JOB TO BE WELDED



PIECES TO BE USED FOR MAKING A TEST WELD.

FIG. 1 — TEST PIECES

2. Hold test pieces at right angles to each other and weld together with one weld. See Fig. 2.

   Caution: Make sure that heat and timing are at a minimum. See Reference "K", "Heat and Time Regulation for Spot Welding".

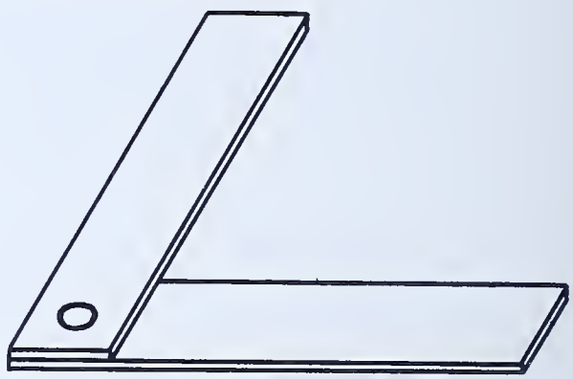


FIG. 2.-TEST WELD

3. Slowly straighten the right angle test weld. This will produce a shearing effect upon the weld and will cause it to break. See Fig. 3.

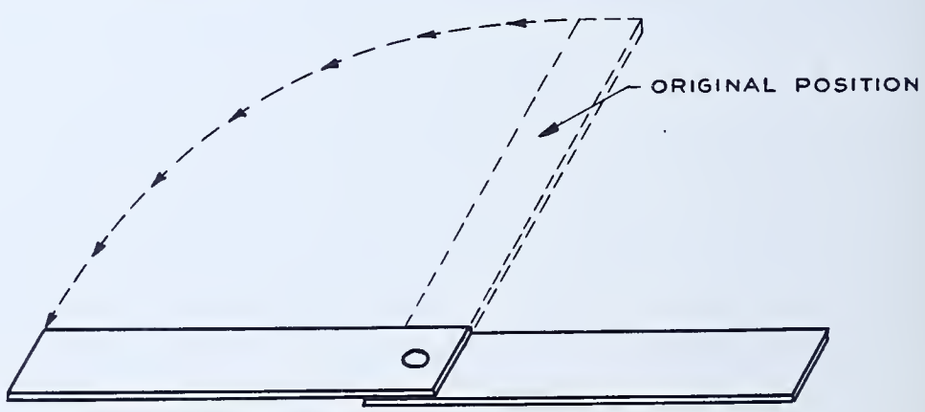


FIG. 3 - TESTING SPOT WELD BY TWISTING

Note:
If the pieces should come apart before the straightened position is reached, the weld is not satisfactory. If the pieces are still holding together and break apart only after the rotating piece has been further rotated past the straight position, the weld can be considered satisfactory for the common run of sheet metal work.

4. Adjust time and heat to produce a satisfactory weld.

5. Lay out weld spacing and spot weld job together. Pieces must be tightly clamped together in their correct positions before the first welds are made. If this precaution is not taken the pieces are likely to move when the first welds are put in place.

HOW TO OPERATE THE NIBBLING MACHINE

General Information:

A nibbling machine is used in the manufacture of flanges and in cutting heavier gauge materials. Inside or outside cuts can be made with the nibbler. It eliminates torch cutting and rotary shear cuts, and is widely used in ornamental design work.

The cutter is about the size of a lead pencil and moves vertically in a one-inch stroke, punching or "nibbling" portions of metal approximately 1/8" wide at a time.

The metal is held in place by an adjustable foot called a "stripper" which must be secured against the face of the metal. In most work the outside circle is cut first to allow use of radius point. (See Note in Step 4.)

Procedure:

1. Locate center of stock by drawing a diagonal. (Material should be 3/4" beyond outer diameter to permit holding in machine.)

2. Lay-off flange diameters (Jobs 3, 4, and 6).

3. Drill or punch 3/8" holes in center for the radius pin.

4. Punch two similar holes, one tangent to inner diameter and one to outer diameter. See Fig. 1, Job 6. (In making flanges nibbler is used only on inside circle. After forming, the lever shear is used for outer diameter).

5. Insert pin of machine and place slide bar clamp for radius of job.

6. Pull down hand lever which permits cutting tool to pass through the tangent hole.

7. Tighten slide bar clamp to this radius.

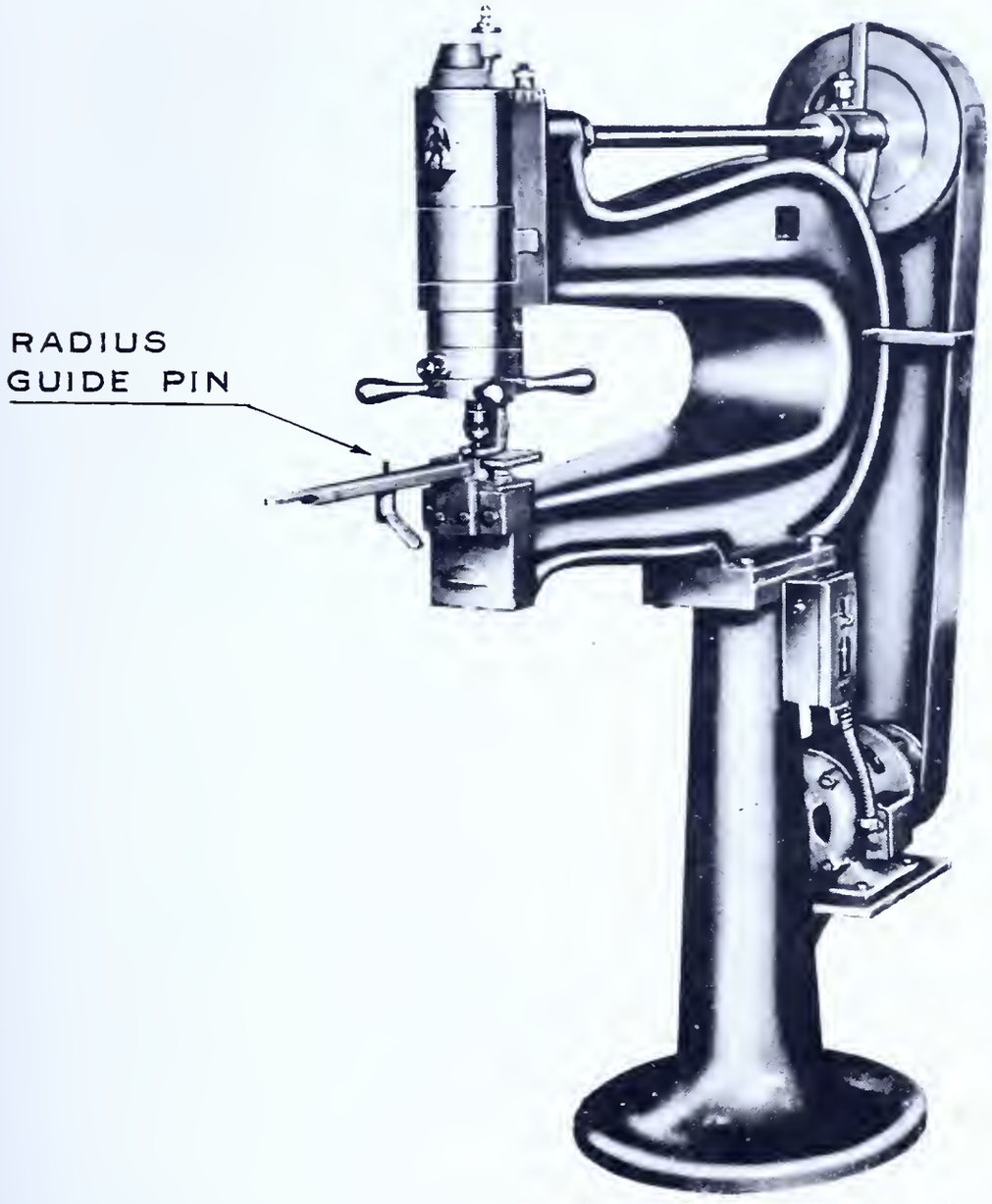
8. Adjust stripper so the stock to be cut will have a free working fit. (If the fit is too close, the stock will not feed freely. If too loose, the stock vibrates and feeds irregularly. Adjustment is made by loosening Stripper Wing Screw Lock and turning Stripper Adjusting Screw to raise and to lower Stripper. When in correct position, tighten Stripper Lock).

9. Operate nibbler to cut outer circle.

10. Change radius adjustment for inner circumference and proceed as before.

11. Grind circumference smooth.

NIBBLING MACHINE



Reproduced by Courtesy of W. J. Savage Co.

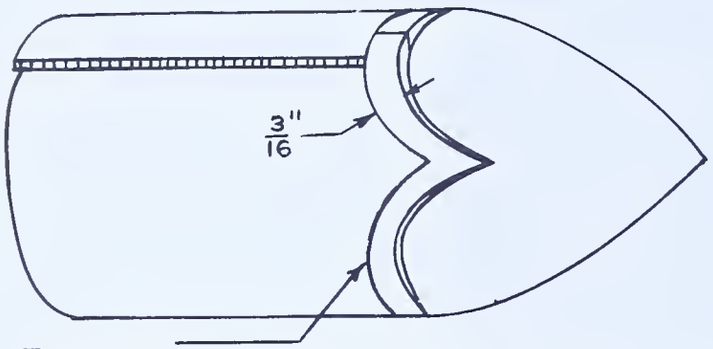
SPECIFICATIONS
THIS MACHINE

Throat Depth	30″	Min. Feed Per Minute	42″
Capacity Mild Steel	1/8″	Max. Feed Per Minute	60″
Capacity Soft Metal	5/32″	Overall Height	64″
Capacity Tough Steel	1/16″	Overall Width	20″
Size Motor Required	1 H.P.	Overall Length	50″
Speed Motor Required	1800 RPM	Net Weight Approx.	1200 lbs.
Strokes Per Minute	850	Domestic Shipping Weight Approx.	1500 lbs.

HOW TO MAKE AND USE SHEET METAL MARKERS

General Information:

When it is necessary to scribe a line in a difficult place, or when a number of similar markings must be made, a sheet metal marking gauge is used. A typical line requiring the use of a marker is shown in Fig. 1.



PROBLEM:- SCRIBE THIS LINE AFTER PIPE HAS BEEN ROLLED & SEAMED TOGETHER.

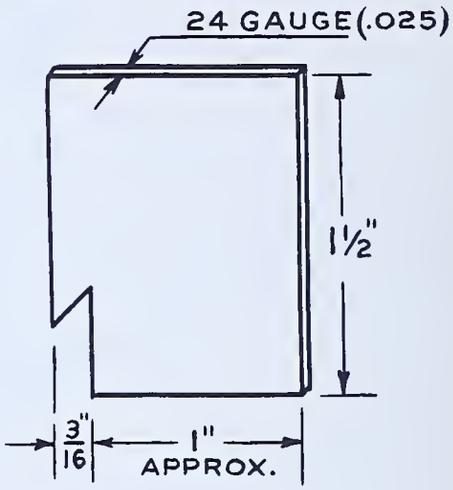


FIG. 1 — SHEET METAL MARKER

How to Make a Marker

Procedure:

1. From a piece of 24 gauge (.025) scrap, cut a square about 1½" x 1½". (Fig. 2).
2. Make a cut "a-a'".
3. Make a cut from "b" ending at "a'".
4. Trim off metal as along line "xx" parallel to "bc" until dimension "y" is as desired.
5. After notching, marker will be slightly slightly twisted. Lay it on a flat stake and flatten with a mallet. Marker is then ready for use. (Fig. 3)

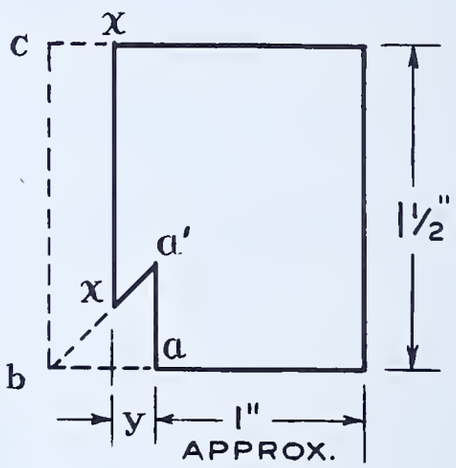
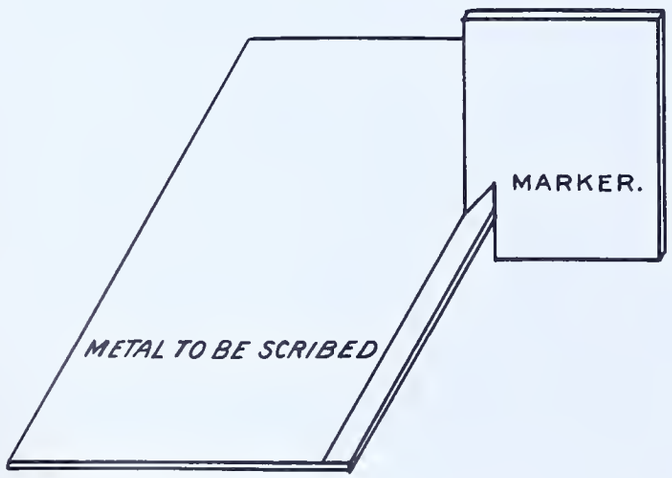


FIG. 2
LAYOUT OF A MARKER



HOLD MARKER SQUARE WITH METAL BEING SCRIBED.

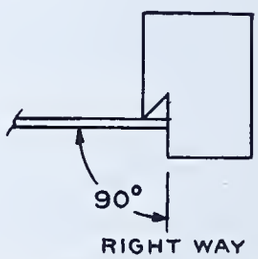


FIG. 3 — HOW TO USE A MARKER

HOW TO MAKE A JOGGLE ON THE CORNICE BRAKE

General Information:

It is sometimes necessary to offset the edge of a piece of metal so that when it is riveted or spot welded to another piece the inside surface will be fair. The offset piece is spoken of as being "joggled". See Fig. 1.

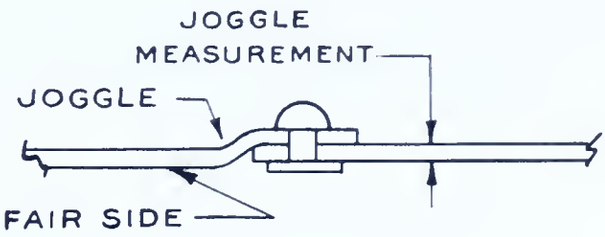


FIG. 1 - JOGGLED & RIVETED LAP

Procedure:

1. Attach a joggle bar that is two gauges thicker than the "joggle measurement" (Fig. 1.) to the bending leaf as in Fig. 2.

2. Place metal in brake and close clamping bar. This will force a slight bend into the metal as shown in Fig. 2.

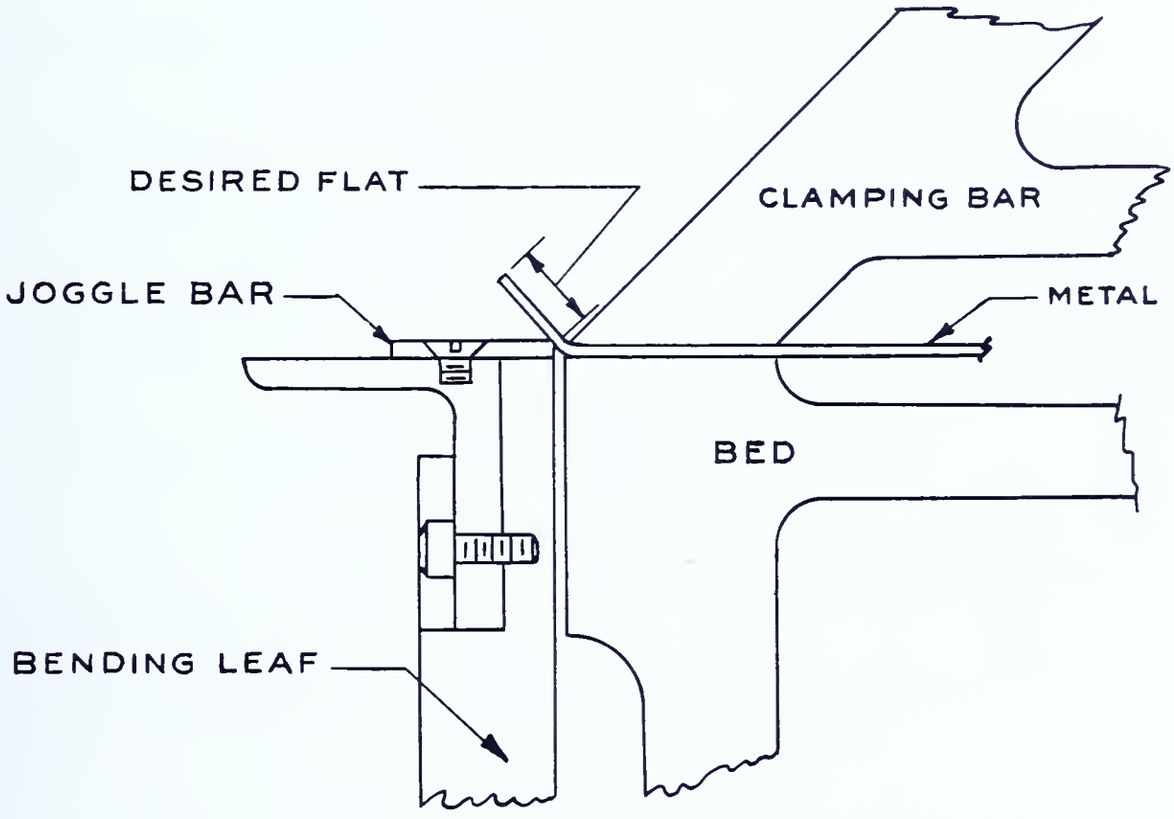


FIG. 2 - JOGGLE BAR IN PLACE

3. Raise bending leaf bringing bend up to "square" as shown in Fig. 3.

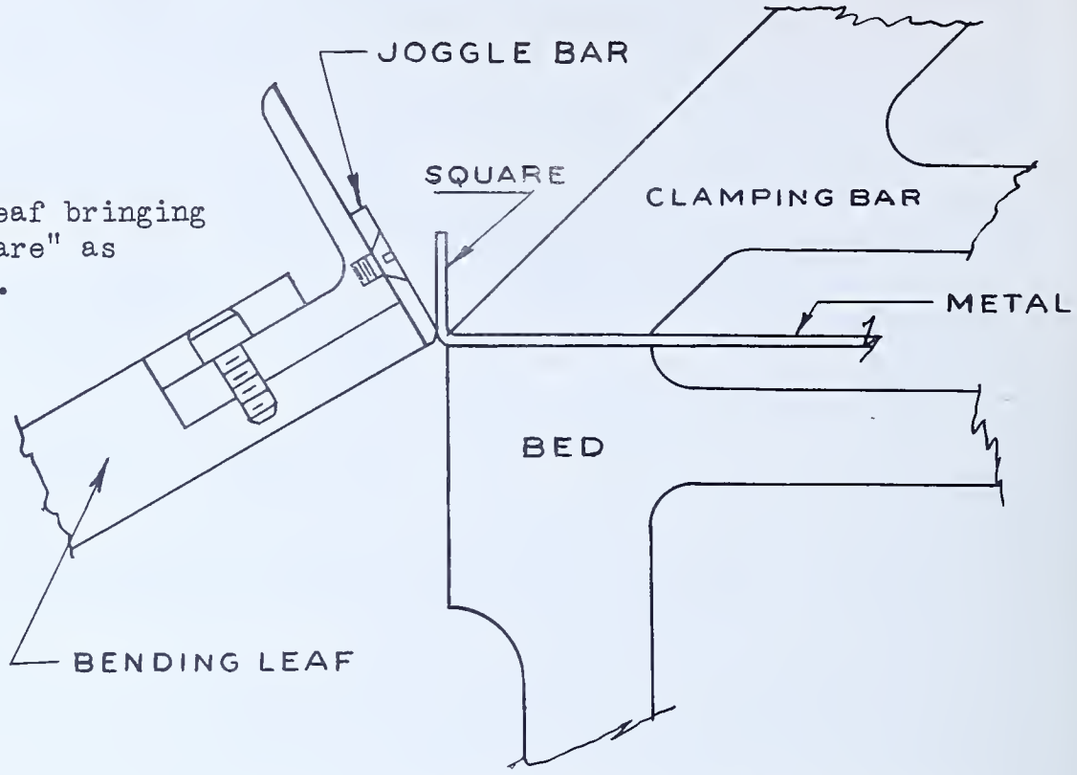


FIG. 3 — BENDING LEAF RAISED

4. Using a mallet flatten metal down on the joggle bar as shown in Fig. 4. This finishes the joggle.

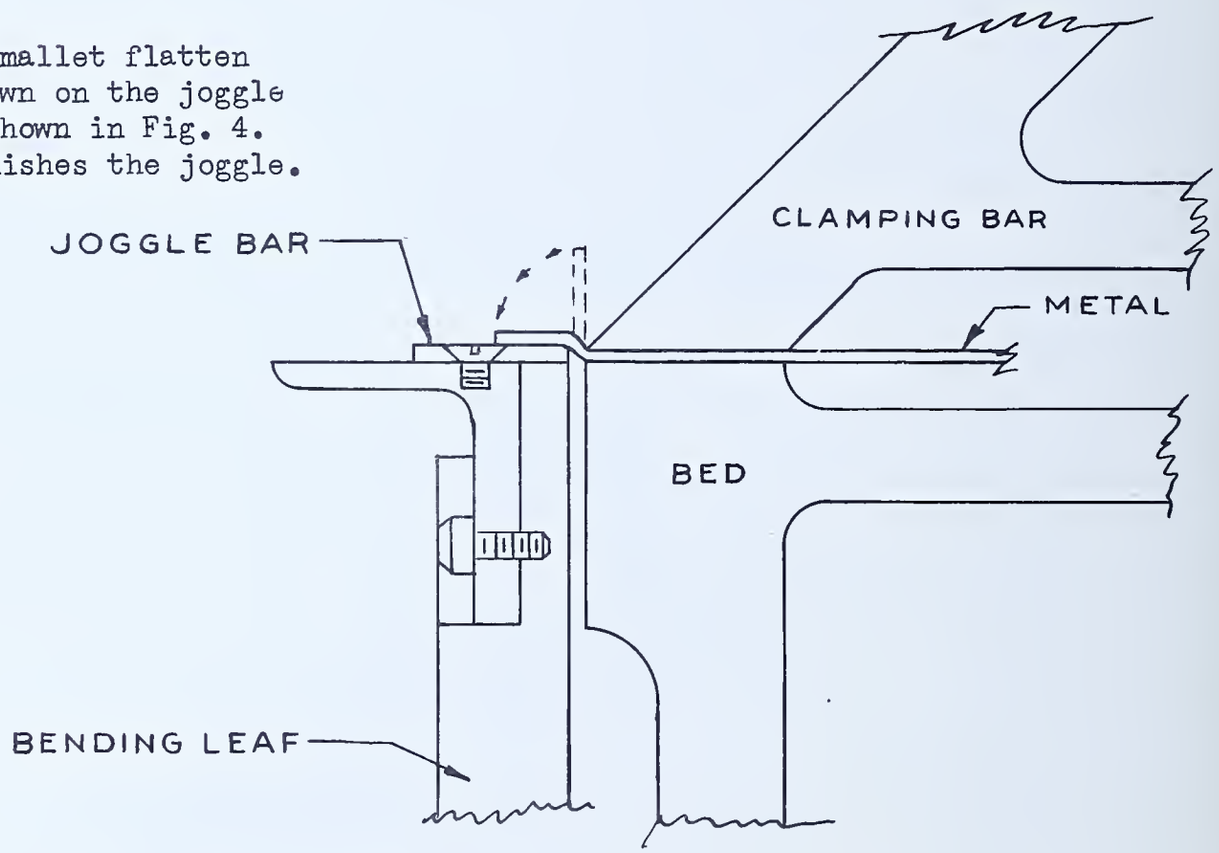


FIG. 4 — JOGGLE COMPLETED

CLOSING A PEENED EDGE

Procedure:

1. Assemble part having single edge into part having double edge. Fig. 1.

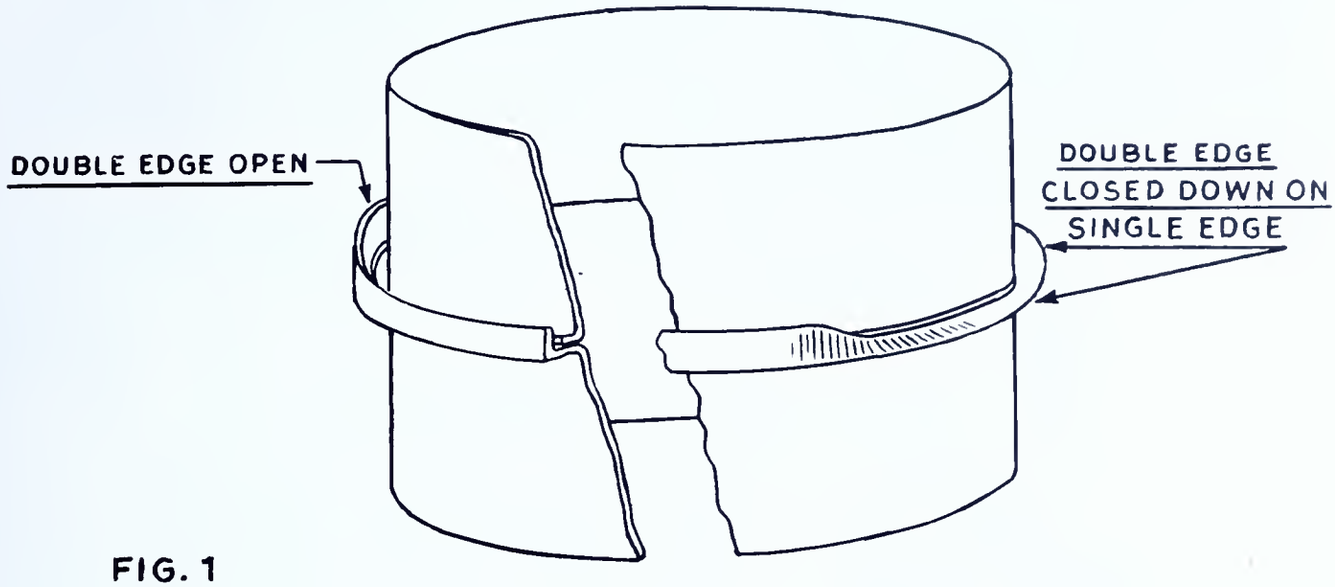


FIG. 1

2. With a setting down hammer partly closed down, double edge all around seam. Fig. 2.

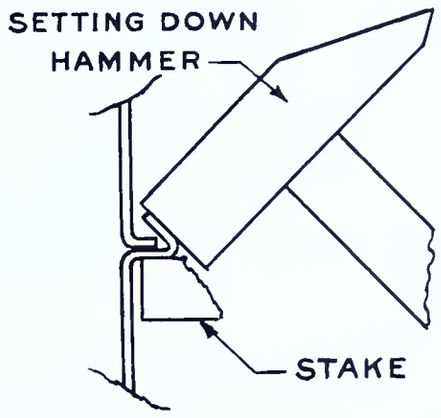


FIG. 2

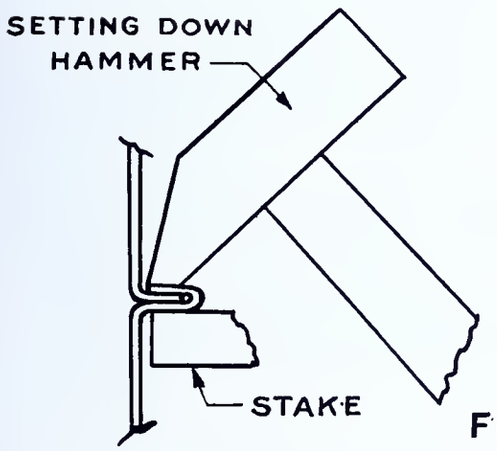


FIG. 3

3. Finish closing down double edge with peening part of setting down hammer. Fig. 3.

AIR TEST OF FUME-TIGHT VENT ASSEMBLIES

General Information:

Before an air test can be made, both ends of the section to be tested must be made air tight. This is done by making temporary end plates and bolting them to the flanges of W.T. spools. In one end plate two 3/8" nipples are inserted, one for air entrance "A" and the other for air exit "B". "A" nipple has a valve to admit a small amount of air at a turn of valve handle. "B" nipple has a mercury gauge which shows the air pressure in ounces per square inch. (See sketch).

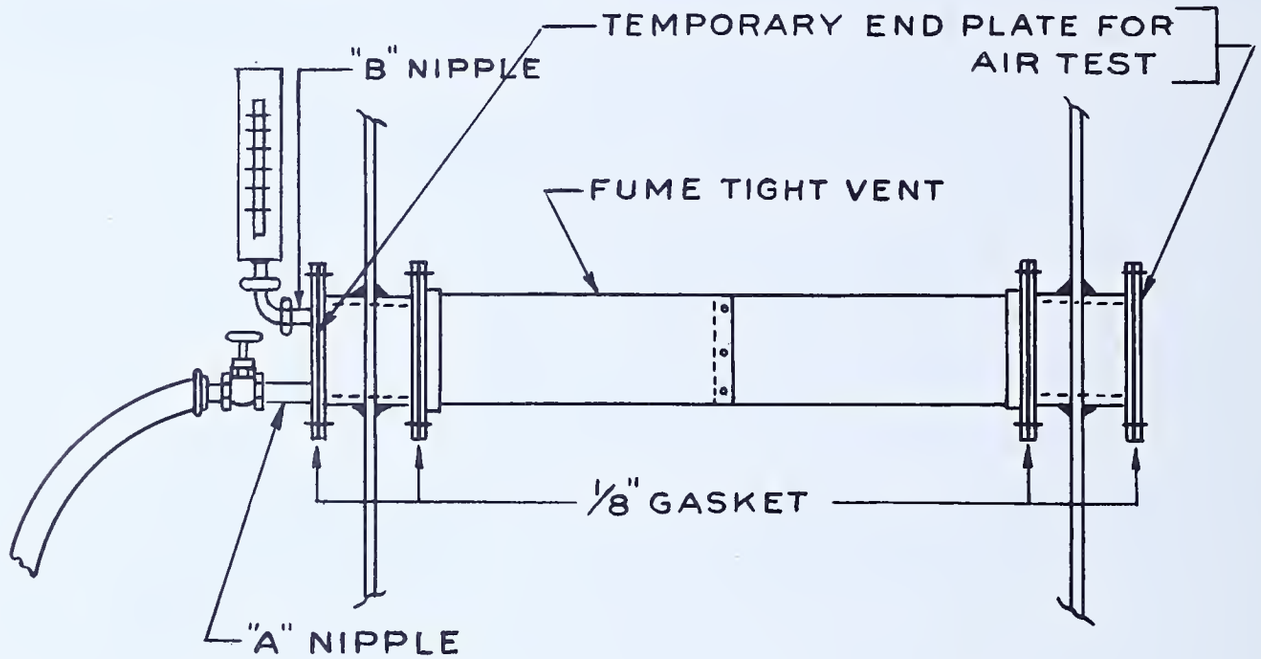


FIG. 1— TESTING FUME TIGHT SECTION

Procedure:

1. Secure two pieces of 5-pound (.125) scrap and make two temporary end plates.
2. Bolt both end plates to section, using 1/8" rubber for gaskets.
3. In one end drill and tap two holes, each to receive a 3/8" nipple.
4. Attach and tighten air test gear.
5. Open air valve slowly until the gauge registers 1 ounce pressure, then shut off valve.
   Caution: Do not allow more air to enter the section that the above amount because excessive pressure would cause the section to burst, resulting in serious personal or property damage.
6. Brush all seams with a soapy water solution.

7. Inspect all seams to see if they are tight.
   If bubbles appear, the seam is not tight and air pressure will not hold.

8. Mark all leaks with crayon or chalk.

9. Disconnect air hose, open valve, and let the air escape.

10. Repair leaks by soldering seams, tightening bolts, etc.

11. Re-test work as indicated in steps 5 and 8. If air pressure holds, work is fume-tight.

Questions:

1. Why is air pressure built up slowly?

2. How do you find leaks?

3. Why is air allowed to escape before soldering leaks?

4. When is test complete?

SHOP ROUTING PROCEDURE

The ventilation drawings for the ship are considered by the proper field man in order that necessary modifications may be made to provide for modifications of original plans or obstructions. The Detail Man checks drawings with the field man and is charged with revision of working sketches to conform with this new information.

When prepared, the sketches are sent to the shop Layer-out, who will, with his assistants, develop patterns for the various shapes to be fabricated.

The leadingman or one of his "pushers" receives the patterns or developments and assigns them to bench hands for fabrication. The leadingman is also responsible for checking and "shipping" (weighing and sending the shapes to the ship).

Apprentices, Helpers or "trainees" may assist in various phases of the work as required. In practice, with the shop on production basis, a trainee may repeatedly make a certain limited range of shapes, arriving at the efficiency of the skilled mechanic on those particular shapes.

REFERENCES TO BASIC HAND AND MACHINE PROCESSES

Note

In considering these references the following should be kept in mind: the basic processes of sheet metal work are identified in detail for each job so that the student or teacher may recognize those abilities which are already possessed and those in which instruction is needed. As mentioned, the New York manuals are referred to for the basic processes which are general to the Sheet Metal trades. Original Reference materials contained in this book are given under the heading "Philadelphia" and are also specifically mentioned in the individual lessons.

PHILADELPHIA AND NEW YORK

SHEET METAL

REFERENCE LIST

Exercise A - Square Shear Blanks

Philadelphia:

1. Ref. A --- Types of Sheet Metal
2. Ref. B --- Standard U.S. Gauges of Sheet Steel

New York:

Machine Processes
P4 - T4 Squaring Shears

Measurement and Layout
P1A-T1A Measuring Tools
P2 - T2 Layout Tools

Exercise B - Make Grooved Seams

Philadelphia:
(none)
New York:

Hand Processes
P11-T11 How to Groove
P16-T16 Hand Punches

Machine Processes
P1 - T1 Bar Folder
P2 - T2 Cornice Brake

Measurement and Layout
P1A - T1A Measuring Tools
P2 - T2 Layout Tools

Exercise C - Prepare Soldering Copper and Solder Seams

Philadelphia:

1. Broemel, "Methods of Soldering", page 180

New York:

Hand Processes
P7 - T7 Files
P9 - T9 Soldering Coppers, Furnaces
T10 Solders and Fluxes

Exercise C (continued)

Machine Processes
(none)

Measurement and Layout
P1A- T1A Measurement Tools
P2 - T2 Layout Tools

Job 1 - Fabricate Round Pipe With Riveted Seam

Philadelphia:
1. Ref. C - "How to Layout a Welded Pipe - (Stretchout Dimensions)"
2. Ref. D - "Layout for Pipe Having Small and Large Ends".

New York:

Hand Processes
P2 - T2 Bench Tools
P3 - T3 Transfer Patterns
P4 - T4 Hand Snips
T10 Solders and Fluxes
P16- T16 Hand Punch
P18- T18 Rivets and Riveting Tools

Machine Processes
P3 - T3 Slip Roll Forming
P4 - T4 Squaring Shears

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 2 - Fabricate Round Pipe With Grooved Seam

New York:

Hand Processes
P2 - T2 Bench Tools
P3 - T3 Transfer Patterns
P4 - T4 Hand Snips
P5 - T5 Stakes
P10- T10 Solders and Fluxes
P11- T11 How to Groove
P16- T16 Hand Punches

Machine Processes
P1 - T1 Bar Folder
P2 - T2 Cornice Brake
P3 - T3 Slip Roll Forming Machine
P4 - T4 Squaring Shears

Job 2 (continued)

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 3 - Fabricate a Fixture for a Circular Flange

Philadelphia:

1. Ref. E --- Description of Flanges
2. Ref. N.--- How to Use the Nibbling Machine
3. Job 4 --- Fabricate a N.W.T. to W.T. Flange

New York:

Hand Processes
P7 - T7 Files
P16- T16 Hand Punches

Machine Processes
(none)

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 4 - Fabricate a N.W.T. to W.T. Flange

Philadelphia:

1. Ref. E --- Description of Flanges

New York:

Hand Processes
P2 - T2 Bench Tools
P7 - T7 Files

Machine Processes
(none)

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 5 - How to Fabricate a Flange Gasket and Grommets

New York:

Hand Processes
P4 - T4 Hand Snips
P15 - T15 Solid and Hollow Punches

Machine Processes
(none)

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 6 - Fabricate an Intermediate N.W.T. Circular Flange

Philadelphia:

1. Ref. E ---Description of Flanges
2. Job 3 ---How to Fabricate a Fixture for a Circular Flange
3. Job 4 ---How to Fabricate an N.W.T. to W.T. Flange

New York:

Hand Processes
P2 - T2 Bench Tools
P7 - T7 Files
P16- T16 Hand Punch
T17A Twist Drills
T17B Hand and Breast Drills

Machine Processes
(none)

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 7 - Fabricate a Fixture For N.W.T. Rectangular Flange

Philadelphia:

1. Ref. K ---Electric Spot Welding
2. Ref. L ---How to Make a Spot Weld
3. Ref. M ---How to Make a Test Weld
4. Ref. E ---Description of Flanges
5. Job 7 ---Fabricate a Fixture for a N.W.T. Flange

New York:

Hand Processes
P2 - T2 Bench Tools
P7 - T7 Files

Job 7 (continued)

T17A Twist Drills
T17B Hand and Breast Drill

Machine Processes
P2 - T2 Cornice Brake

Measurement and Layout
P1A- T1A Measurement Tools
P2 - T2 Layout Tools

Job 8 - Fabricate a N.W.T. Rectangular Flange

Philadelphia:

1. Ref. K ---Electric Spot Welding
2. Ref. L ---How to Make a Spot Weld
3. Ref. M ---How to Make a Test Weld
4. Ref. E ---Description of Flanges
5. Job 7 ---Fabricate a Fixture for a N.W.T. Flange

New York:

Hand Processes
P2 - T2 Bench Tools
P7 - T7 Files
T17A Twist Drills
T17B Hand and Breast Drills

Machine Processes
P2 - T2 Cornice Brake

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 9 - Fabricate a Spool

Philadelphia:

1. Ref. C ---How to Layout a Welded Pipe (Stretchout Dimensions)
2. Ref. E ---Description of Flanges
3. Ref. N ---How to Use the Nibbling Machine

New York:

Hand Processes
P3 - T3 Transfer Patterns
P7 - T7 Files
T17A Twist Drills
T17B Hand and Breast Drill

Job 9 (continued)

Machine Processes
P3 - T3 Slip Roll Forming Machine
P4 - T4 Squaring Shears
P10- T10 Bench or Floor Grinders

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 10 - Assemble Pipe Sections and Fit to Spools

Philadelphia:

1. Job 5 ---Fabricate a Flange Gasket and Grommets
2. Ref. R ---Air Test of Fume Vent Assemblies

New York:

Hand Processes
P2 - T2 Bench Tools
P4 - T4 Hand Snips
P9 - T9 Soldering Coppers and Furnaces
T10 Solders and Fluxes
P18- T18 Rivets and Riveting Tools

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 11 - Fabricate Rectangular Duct with Double Seam, Pittsburgh Lock, and Slip Connection

Philadelphia:

1. Ref. G ---Double Seaming
2. Ref. H ---Pittsburgh Lock Seams
3. Ref. E ---Description of Flanges
4. Job 12 ---Fabricate a Flat Slip
5. Job 4 ---Fabricate a Flange N.W.T. to W.T.

New York:

Hand Processes
P3 - T3 Transfer Patterns
P4 - T4 Hand Snips
T10 Solders and Fluxes
P18- T18 Rivets and Riveting Tools

Job 11 (continued)

Machine Processes
P2 - T2 Cornice Brake
P4 - T4 Squaring Shears

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 12 - Fabricate a Flat Slip

New York:

Hand Processes
P4 - T4 Hand Snips
P5 - T5 Stakes
P7 - T7 Files

Machine Processes
P2 - T2 Cornice Brake
P4 - T4 Squaring Shears

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 13 - Fabricate a Joint of Flat Oval Pipe

Philadelphia:

1. Ref. E ---Description of Flanges
2. Job 4 ---Fabricate a Flange N.W.T. to W.T.

New York:

Hand Processes
P4 - T4 Hand Snips
T10 Solders and Fluxes
P16- T16 Hand Punch
P18- T18 Rivets and Riveting Tools

Machine Processes
P2 - T2 Cornice Brake
P3 - T3 Slip Roll Forming Machine
P4 - T4 Squaring Shears

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 14 - Fabricate a 90 Degree T-Collar, Diameters Equal

Philadelphia:

1. Ref. O ---How to Make and Use Sheet Metal Markers

New York:

Hand Processes
P2 - T2 Bench Tools
P4 - T4 Hand Snips
P5 - T5 Stakes
P7 - T7 Files
T10 Solders and Fluxes
P11- T11 How to Groove
P14- T14 Principles of Flanging
P16- T16 Hand Punch
P18- T18 Rivets and Riveting Tools

Machine Processes
P1 - T1 Bar Folder
P2 - T2 Cornice Brake
P3 - T3 Slip Roll Forming Machine
P4 - T4 Squaring Shears
P8 - T8 Turning Machines
P9 - T9 Burring Machines

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 15 - Fabricate a 45 Degree Collar, Diameters Equal

Philadelphia:

1. Ref. O ---How to Make and Use Sheet Metal Markers

New York:

Hand Processes
P2 - T2 Bench Tools
P4 - T4 Hand Snips
P5 - T5 Stakes
P7 - T7 Files
T10 Solders and Fluxes
P11- T11 How to Groove
P14- T14 Principles of Flanging
P16- T16 Hand Punch
T17A Twist Drills
T17B Hand and Breast Drills
P18- T18 Rivets and Riveting Tools

Job 15 (continued)

Machine Processes
P1 - T1 Bar Folder
P2 - T2 Cornice Brake
P3 - T3 Slip Roll Forming Machine
P4 - T4 Squaring Shears
P8 - T8 Turning Machine
P9 - T9 Burring Machine

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 16 (Same References as for Job 15)

Job 17 - Fabricate a 45 Degree Circular Collar on Corner of Rect. Pipe

Philadelphia:

1. Ref. P ---How to Make a Joggle on a Cornice Brake

New York:

Hand Processes
P2 - T2 Bench Tools
P3 - T3 Transfer Patterns
P4 - T4 Hand Snips
P5 - T5 Stakes
P9 - T9 Soldering Coppers and Furnaces
T10 Solders and Fluxes
P11- T11 How to Groove
P14- T14 Principles of Flanging
P16- T16 Hand Punches
P18- T18 Rivets and Riveting Tools

Machine Processes
P1 - T1 Bar Folder
P2 - T2 Cornice Brake
P3 - T3 Slip Roll Forming Machine
P4 - T4 Squaring Shears
P8 - T8 Turning Machine

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 18 - Fabricate a 45 Degree Shoe Collar, Diameters Equal

Philadelphia:

1. Ref. Q ---Closing a Peened Edge

New York:

Hand Processes
P3 - T3 Transfer Patterns
P4 - T4 Hand Snips
P5 - T5 Stakes
T10 Solders and Fluxes
P9 - T9 Soldering Coppers and Furnaces
P16- T16 Hand Punches
P18- T18 Rivets and Riveting Tools

Machine Processes
P3 - T3 Slip Roll Forming Machine
P4 - T4 Squaring Shears
P8 - T8 Turning Machine

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 19 - Fabricate a Central Reducer

New York:

Hand Processes
P3 - T3 Transfer Patterns
P4 - T4 Hand Snips
P5 - T5 Stakes
T10 Solders and Fluxes
P9 - T9 Soldering Coppers and Furnaces
P18- T18 Rivets and Riveting Tools

Machine Processes
P1 - T1 Bar folder
P2 - T2 Cornice Brake
P3 - T3 Slip Roll Forming Machine
P4 - T4 Squaring Shears
P8 - T8 Turning Machine

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 20 - Fabricate an Off-Center Reducer, Round to Round

New York:

Hand Processes
P2 - T2 Bench Tools
P3 - T3 Transfer Patterns
P4 - T4 Hand Snips
P9 - T9 Soldering Coppers and Furnaces
T10 Solders and Fluxes
P18- T18 Rivets and Riveting Tools

Machine Processes
P3 - T3 Slip Roll Forming Machine
P4 - T4 Squaring Shears
P8 - T8 Turning Machine

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 21 - Fabricate a 30 Degree Collar on a Reducer

New York:

Hand Processes
P3 - T3 Transfer Patterns
P4 - T4 Hand Snips
P9 - T9 Soldering Coppers and Furnaces
T10 Solders and Fluxes
P14- T14 Principles of Flanging
P16- T16 Hand Punches
P18- T18 Rivets and Riveting Tools

Machine Processes
P3 - T3 Slip Roll Forming Machine
P4 - T4 Squaring Shears
P8 - T8 Turning Machine

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 22 - Fabricate an Off-Center Rectangular Reducer

New York:

Hand Processes
P3 - T3 Transfer Patterns
P16- T16 Hand Punches
P18- T18 Rivets and Riveting Tools

Machine Processes
P2 - T2 Cornice Brake

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 23 - Fabricate a Double-Seamed Rectangular Elbow

Philadelphia:
1. Job 4 ---How to Fabricate a N.W.T. to W.T. Flange
2. Ref G ---Double Seaming

New York:

Hand Processes

P2 - T2 Bench Tools
P3 - T3 Transfer Patterns
P4 - T4 Hand Snips
P5 - T5 Stakes
T10 Solders and Fluxes
P14- T14 Principles of Flanging
P16- T16 Hand Punches
P18- T18 Rivets and Riveting Tools

Machine Processes

P3 - T3 Slip Roll Forming Machine
P4 - T4 Squaring Shears
P8 - T8 Turning Machines
P11 How to Grind Tools

Measurement and Layout

P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 24 - Fabricate a Round Peened Elbow

Philadelphia:

1. Job 4 ---How to Fabricate a N.W.T. to W.T. Flange

New York:

Hand Processes

P3 - T3 Transfer Patterns
P4 - T4 Hand Snips
P5 - T5 Stakes
P9 - T9 Soldering Coppers and Furnaces
T10 Solders and Fluxes
P16- T16 Hand Punches
P18- T18 Rivets and Riveting Tools

Machine Processes

P3 - T3 Slip Roll Forming Machine
P4 - T4 Squaring Shears
P8 - T8 Turning Machines
P11 How to Grind Tools

Measurement and Layout

P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 25 - Fabricate a Flat Oval Elbow

New York:

Hand Processes

P3 - T3 Transfer Patterns
P5 - T5 Stakes

P9 - T9 Soldering Coppers and Furnaces
T10 Solders and Fluxes
P16- T16 Hand Punches
P18- T18 Rivets and Riveting Tools

Machine Processes
P3 - T3 Slip Roll Forming Machine
P4 - T4 Squaring Shears
P11 How to Grind Tools

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 26 - Fabricate a Central Rect. to Round Transformer

Philadelphia:

1. Job 8 ---Fabricate a N.W.T. Rectangular Flange

New York:

Hand Processes
P3 - T3 Transfer Patterns
P4 - T4 Hand Snips
T10 Solder and Fluxes
P9 - T9 Soldering Coppers and Furnaces
P14- T14 Principles of Flanging

Machine Processes
P2 - T2 Cornice Brake
P3 - T3 Slip Roll Forming Machine
P4 - T4 Squaring Shears

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 27 - Fabricate an Off-Center Flat Oval to Round Transformer

Philadelphia:

1. Job 4 ---Fabricate a N.W.T. to W.T. Flange

New York:

Hand Processes
P2 - T2 Bench Tools
P3 - T3 Transfer Patterns
P4 - T4 Hand Snips
P9 - T9 Soldering Coppers and Furnaces
P14- T14 Principles of Flanging

Machine Processes
P3 - T3 Slip Roll Forming Machine
P4 - T4 Squaring Shears

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 28 - Fabricate an Off-Center Flat Oval to Rectangular Transformer

Philadelphia:

1. Job 26 ---Fabricate a Central Rectangular to Round Transformer

New York:

Hand Processes
P3 - T3 Transfer Patterns
P4 - T4 Hand Snips
P9 - T9 Soldering Coppers and Furnaces
T10 Solders and Fluxes
P16- T16 Hand Punches
P18- T18 Rivets and Riveting Tools

Machine Processes
P2 - T2 Cornice Brake
P3 - T3 Slip Roll Forming Machine
P4 - T4 Squaring Shears

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 29 - Fabricate a Rectangular Ogee Offset

Philadelphia:

1. Ref. P ---How to Make a Joggle on the Cornice Brake
2. Ref. H ---Pittsburgh Lock Seam

New York:

Hand Processes
P3 - T3 Transfer Patterns
P4 - T4 Hand Snips
P5 - T5 Stakes
P9 - T9 Soldering Coppers and Furnaces
T10 Solders and Fluxes
P16- T16 Hand Punches

Machine Processes
P2 - T2 Cornice Brake
P3 - T3 Slip Roll Forming Machine
P4 - T4 Squaring Shears
P8 - T8 Turning Machines

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 30 - Fabricate a N.W.T. Circular Offset

New York:

Hand Processes
P3 - T3 Transfer Patterns
P9 - T9 Soldering Coppers and Furnaces
T10 Solders and Fluxes
P14- T14 Principles of Flanging
P16- T16 Hand Punches
P18- T18 Rivets and Riveting Tools

Machine Processes
P3 - T3 Slip Roll Forming Machine
P4 - T4 Squaring Shears
P11 How to Grind Tools

Measurements and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 31 - Fabricate a Five Piece Flat Oval N.W.T. Offset

New York:

Hand Processes
P3 - T3 Transfer Patterns
T10 Solders and Fluxes
P9 - T9 Soldering Coppers and Furnaces
P14- T14 Principles of Flanging
P16- T16 Hand Punches
P18- T18 Rivets and Riveting Tools

Machine Processes
P2 - T2 Slip Roll Forming Machine
P4 - T4 Squaring Shears
P11 How to Grind Tools

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 32 - Fabricate a Hanger

New York:

Machine Processes
P3 - T3 Slip Roll Forming Machine
P10- T10 Bench or Floor Grinder

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 33 - Fabricate a Drop Rectangular Elbow

New York:

Hand Processes
P3 - T3 Transfer Patterns
P4 - T4 Hand Snips
T10 Solders and Fluxes
P18- T18 Rivets and Riveting Tools

Machine Processes
P1 - T1 Bar Folder
P2 - T2 Cornice Brake
P3 - T3 Slip Roll Forming Machine
P8 - T8 Turning Machine
P9 - T9 Burring Machines

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

Job 34 - Fabricate a Central Y Branch

New York:

Hand Processes
P3 - T3 Transfer Patterns
P4 - T4 Hand Snips
T10 Solders and Fluxes
P18- T18 Rivets and Riveting Tools

Machine Processes
P1 - T1 Bar Folder
P2 - T2 Cornice Brake
P3 - T3 Slip Roll Forming Machine
P8 - T8 Turning Machine
P9 - T9 Burring Machine

Measurement and Layout
P1A- T1A Measuring Tools
P2 - T2 Layout Tools

GENERAL REFERENCES

Broemel, L. and J. S. Daugherty - Sheet Metal Worker's Manual
F. J. Drake Co., Chicago, Ill., 1940

Daugherty, James S. - Sheet Metal Pattern Drafting and Shop Practice
Manual Arts Press - Peoria, Illinois

Funk, Harold L. - Short Pattern Method for Fittings Having Straight
Line of Projection - Sheet Metal Publishing Co., New York

I. C. S. Text Books on Sheet Metal Development
International Text Book Co.

Kidder, F. S. - Triangulation Applied to Sheet Metal Pattern Cutting
Sheet Metal Publication Co., 1937

Morris C. O. - Sheet Metal Drafting and Related Mathematics for Sheet
Metal Trade - C. O. Morris, Collingswood, N. J., 1940

Neubecker, William - The Universal Sheet Metal Pattern Cutter
Volumes I and II - Sheet Metal Publication Co., N. Y., 1941

Neubecker, William - Pattern Drafting for Heat and Vent Work
New York Trade School - 1932

Neubecker, William - Sheet Metal Work -
American Technical Society, 1941

Poe, Ralph W. - Short Methods of Pattern Development
American Rolling Mill Co. - Middletown, Ohio.